American City & County

public works engineering and management

NOVEMBER 1980

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LOW PRESSURE AIR TESTING: HOW TIGHT A SEWER SPEC?

PUBLIC WORKS GARAGES CAN BE GOOD NEIGHBORS

TOUGH SNOWPLOW BLADES THAT SAVE BIG BUCKS

RESOURCE RECOVERY:

What type of organization is needed to make it work?

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SR.VICE PRESIDENT
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WASHINGTON

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On the cover: *This ten-foot-long, three-foot-diameter trommel screen is operated by the National Center for Resource Recovery under a U.S. Department of Energy contract intended to improve waste separation processes by examining such variables as trommel rotational speed and slope. Important as hardware considerations are, they are secondary to achieving a local organizational structure that ensures efficient operation of the resource recovery facility. The article on page 39 discusses four different, successful multi-town agreements.*

Municipal Cost Indexes

Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 269.3 +0.8% +11.1%

ACC Construction Cost Index	299.7	1.2%	7.1%	Energy: Fuels and Power	695.9	0.6%	30.8%
General Construction Materials	280.2	0.7	5.7	Consumable Supplies	257.9	1.6	16.2
Motorized Equipment	244.8	1.2	12.6	Producer Price Index	249.0	1.0	14.6

CONSUMER PRICE INDEX 249.4 +0.6% +12.8%

Atlanta, Georgia[2]	249.7	Denver, Colorado[1]	265.8	Minneapolis, Minnesota[2]	250.6
Boston, Massachusetts[1]	240.9	Kansas City, Missouri[2]	249.3	New York, New York	240.7
Chicago, Illinois	245.4	Los Angeles, California	250.1	Portland, Oregon[1]	252.2
Dallas-Fort Worth, Texas[2]	257.4	Miami, Florida (11/77 = 100)[1]	134.7	Washington, DC[1]	248.7

CAPITAL EQUIPMENT 241.9 +0.7% +11.7%

Agricultural Machinery & Equip.	258.9	0.6%	11.0%	Internal Combustion Engines	269.3	0.5%	12.5%
Air Conditioners (12/77 = 100)	123.6	0.7	9.8	Motor Trucks	235.2	2.0	15.6
Construction Machinery & Equip.	292.8	0.7	13.3	Office Machines	141.7	0.2[2]	6.1
Electric Motors	252.4	0.1	8.6	Passenger Cars	192.2	1.5	12.1
Elevators and Escalators	243.8	(0.2)	13.6	Photographic Equipment	126.5	0.3	9.1
Fans and Blowers (Ex. Portable)	298.1	1.0	10.3	Pumps, Compressors & Equipment	290.3	0.8	15.6
Fluid Power Equipment	201.2	0.1[2]	14.1	Railroad Equipment	316.4	0[2]	12.6
Generators and Generator Sets	303.7	1.2[2]	27.0	Refrig. Compressors (12/77 = 100)	122.5	0.3[2]	10.6
Heating Equipment	208.0	0.9[2]	10.6	Scales and Balances	214.9	4.0[2]	11.1
Industrial Material Handling Equip.	255.3	0.1[2]	9.5	Switchgear, Switchboard Equip.	230.9	(0.5)	14.0
Integrating & Measuring Inst.	185.8	0.1	8.1				

INDUSTRIAL COMMODITIES 277.3 +0.6% +15.4%

Abrasive Products	256.5	0.2%[2]	14.4%	Lumber	333.5	1.9%	(8.7)%
Agricultural Chemicals	259.6	0.5	21.6	Mixed Fertilizers	241.8	(0.3)	19.4
Apparel	174.8	0.4	8.3	Motor Vehicle Parts	254.4	3.5	11.9
Asphalt Roofing	409.4	(0.6)	25.6	Natural Gas	850.1	0.3[2]	28.2
Building Paper and Board	209.2	(1.2)	16.8	Nonferrous Wire and Cable	215.8	2.4	16.7
Coal	469.0	0.3	3.3	Paint Materials	278.2	0.4	12.2
Commercial Furniture	237.1	0[2]	6.5	Paper	258.8	0.1	12.8
Concrete Products	275.9	0	12.0	Paperboard	238.1	0.3	15.4
Diesel Fuel (2/72 = 100)	705.5	0.9[2]	39.5	Pesticides	375.3	0[2]	8.4
Drugs and Pharmaceuticals	208.8	0.3[2]	7.7	Photographic Supplies	258.2	0	49.8
Electric Lamps/Bulbs	261.7	0.5[2]	9.4	Plastic Constr. Prod. (12/69 = 100)	159.3	1.2	4.0
Electric Power	333.8	0.7	19.7	Plastic Film (12/70 = 100)	195.0	1.8	10.4
Electronic Components	158.2	1.0	15.4	Plumbing Fixtures & Brass Fittings	250.4	0.3	12.6
Fabricated Structural Metal	272.6	0.3	8.1	Plywood	262.3	4.5	3.1
Finished Lubricants	319.6	1.7[2]	29.3	Portland Cement	310.3	(0.1)	8.7
Finished Steel Products	299.5	0	5.6	Prepared Paint	239.1	1.0[2]	16.5
Flat Glass	199.5	2.7[2]	8.4	Protective Clothing (6/78 = 100)	126.0	(0.2)[2]	4.0
Floor Coverings	163.5	0.2	9.0	Refractories	271.4	0.7	12.3
Footwear	233.9	0.4	3.8	Residual Fuel	949.0	0.9	25.6
Footwear, Rubber	216.4	0	4.5	Sand, Gravel & Crushed Stone	235.9	0.2	13.0
Fuel Oil, No. 2 (2/73 = 100)	705.8	0.5	37.7	Sanitary Papers & Health Prod.	335.3	1.1	16.3
Gasoline	651.0	0.4	50.3	Soaps & Synthetic Detergents	219.7	3.2[2]	11.5
Glass Containers	294.6	0	11.1	Sporting Goods	201.0	0.3	13.2
Gypsum Products	251.8	(0.5)	(0.2)	Structural Clay Products	229.8	(0.2)[2]	3.4
Hand Tools	283.0	0.7	13.8	Tires and Tubes	237.0	0	12.0
Hand Tools, Power Driven	194.8	0.5[2]	11.7	Tractor Parts	181.2	0[2]	7.0
Hardware	227.5	0.1[2]	8.5	Transformers & Power Regulators	187.7	2.1[2]	14.9
Industrial Chemicals	329.0	0.4[2]	18.7	Valves & Fittings	291.2	0	12.3
Kerosene (2/73 = 100)	681.4	0.5	40.5	Wiring Devices	271.1	0.8	9.7

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted City indexes: 1 — updated odd months, 2 — updated even months, all others monthly.

DECEMBER 1980

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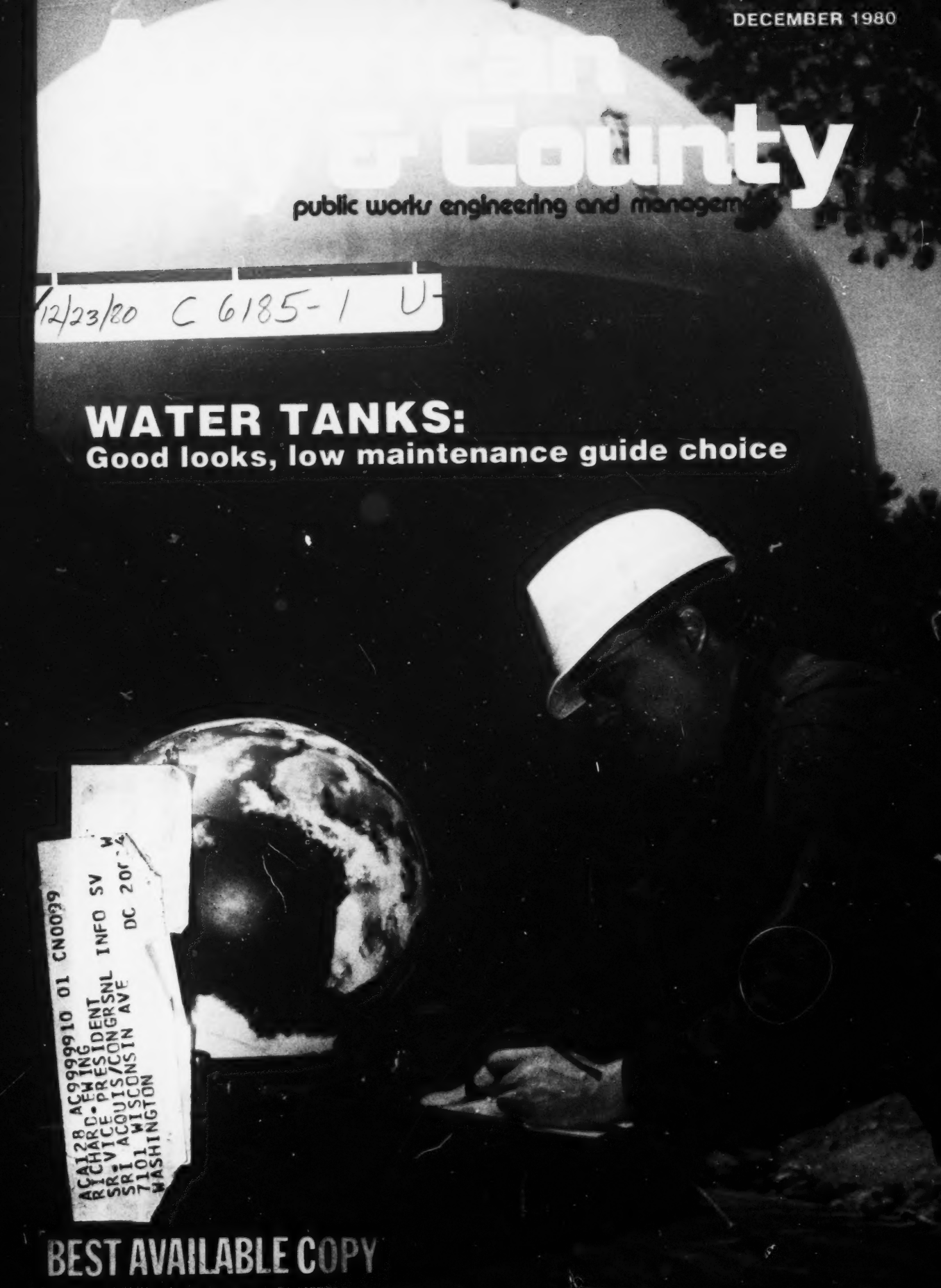
WATER TANKS:
Good looks, low maintenance guide choice



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The MCI goes up 0.8% this month and 11.7% for the year.

On the cover: The importance of aesthetics in the choice of water storage tank design is underscored as an artist prepares to paint the Washington Suburban Sanitary Commission's 2.0 million gallon structure in Germantown, Maryland. Based on this scale model developed from photographs of the earth as Apollo astronauts saw it from 20,000 miles in space, the paint job on this Chicago Bridge & Iron spheroidal steel tank cost WSSC $140,000 and is expected to last 20 years. For a look at the finished product, turn to page 19.

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Chicago, Illinois	249.5	Los Angeles, California	252.0	Portland, Oregon[1]	255.4
Dallas-Fort Worth, Texas[2]	257.4	Miami, Florida (11/77 = 100)[1]	134.9	Washington, DC[1]	251.8

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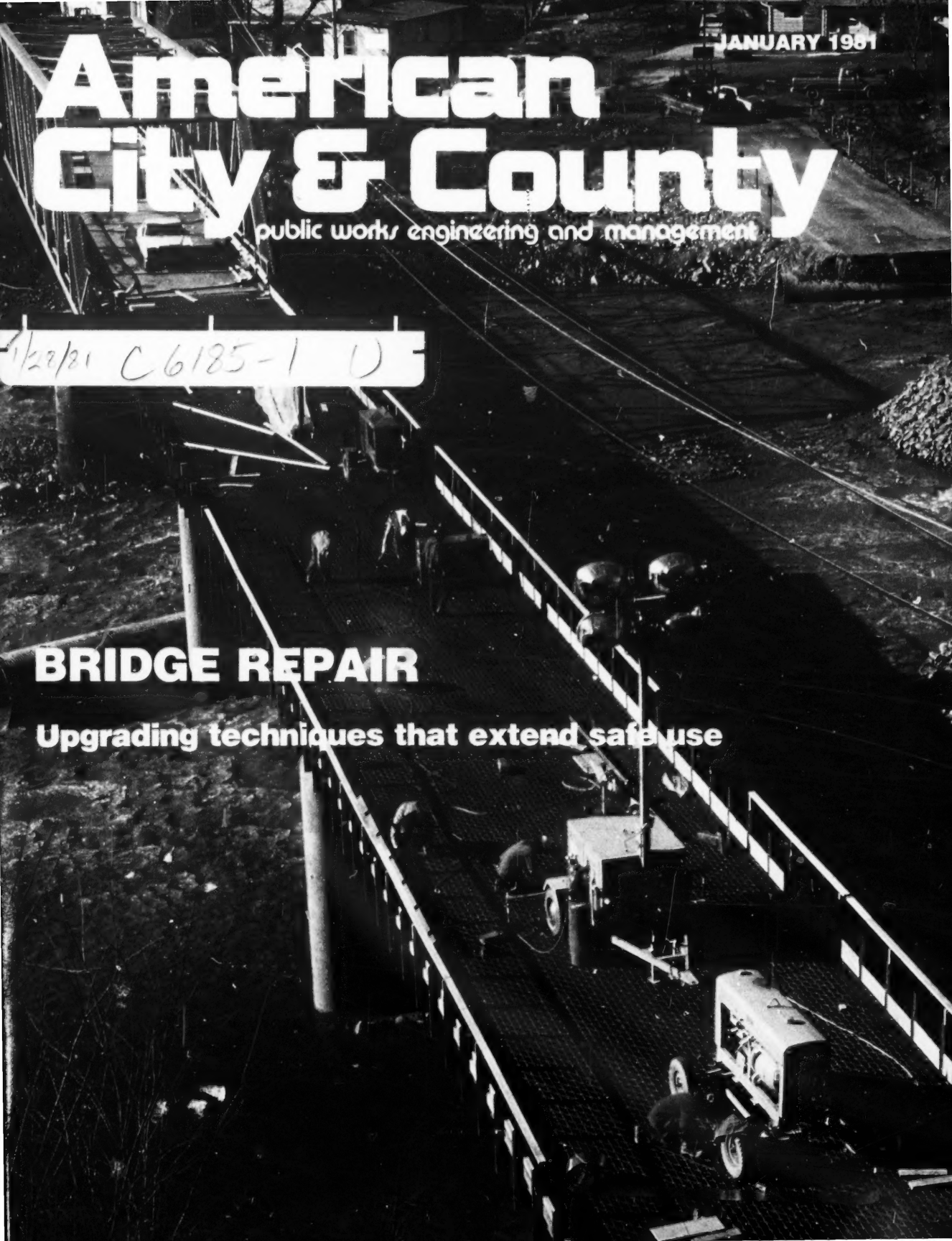

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On the cover: Recognizing the impossibility of replacing all the deficient bridges that the federally mandated bridge inventory — due to be complete this month — will disclose, the $4.2 billion Federal Highway Administration bridge program provides funds for rehabilitation, not just replacement. One common method of upgrading a structurally deficient bridge is to reduce the dead load by replacing a heavy deck with a lighter one, as shown in the cover photograph from Greulich, Inc., For information on other rehab methods, turn to page 29.

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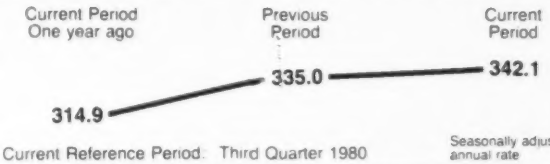
Motorized Equipment	251.8	4.0	11.9
Energy; Fuels and Power	708.3	0.2	25.3
Consumable Supplies	262.3	1.0	14.6
Producer Price Index	252.2	1.3	12.5

MUNICIPAL TREND TO WATCH

Purchases of Goods and Services, Billions of Dollars



Current Reference Period: Third Quarter 1980

Seasonally adjusted annual rate

CAPITAL EQUIPMENT 248.2 +2.9% +11.4%

Agricultural Machinery & Equip.	262.8	0.1%	9.5%
Air Conditioners (12/77 = 100)	123.6	0	8.2
Construction Machinery & Equip.	298.4	1.2	13.1
Electric Motors	254.9	0.2	6.8
Elevators and Escalators	248.4	0.8	13.2
Fans and Blowers (Ex. Portable)	302.2	0.6	9.7
Fluid Power Equipment	206.5	2.1[2]	14.7
Generators and Generator Sets	307.5	1.3[2]	26.2
Heating Equipment	210.0	0.6[2]	9.3
Industrial Material Handling Equip.	259.2	1.2[2]	8.9
Integrating & Measuring Inst.	187.6	0.8	7.4
Internal Combustion Engines	276.8	0.9%	11.7%
Motor Trucks	247.9	8.9	13.2
Office Machines	142.4	0.5[2]	5.9
Passenger Cars	198.0	8.2	9.3
Photographic Equipment	124.5	(0.2)	4.7
Pumps, Compressors & Equipment	296.4	1.6	15.7
Railroad Equipment	323.3	1.0[2]	12.9
Refrig. Compressors (12/77 = 100)	127.8	0[2]	9.7
Scales and Balances	214.9	0[2]	10.9
Switchgear, Switchboard Equip.	231.9	0.6	12.9

INDUSTRIAL COMMODITIES 281.2 +1.1% +13.2%

Abrasive Products	259.7	0.7%[2]	12.3%
Agricultural Chemicals	260.0	(0.2)	16.2
Apparel	175.5	0 5	8.2
Asphalt Roofing	408.4	0.5	21.0
Building Paper and Board	212.1	1.2	15.6
Coal	471.0	(0.2)	3.6
Commercial Furniture	241.2	1.6[2]	8.0
Concrete Products	276.9	(0.2)	10.7
Diesel Fuel (2/72 = 100)	700.0	(0.5)[2]	23.4
Drugs and Pharmaceuticals	212.3	(0.2)[2]	9.5
Electric Lamps/Bulbs	262.3	0.4[2]	9.6
Electric Power	337.6	(0.3)	19.1
Electronic Components	160.6	0.1	14.8
Fabricated Structural Metal	276.2	0.9	7.8
Finished Lubricants	322.7	0.6[2]	26.0
Finished Steel Products	306.3	2.3	6.5
Flat Glass	200.7	0.5[2]	8.7
Floor Coverings	164.5	0.4	8.2
Footwear	236.8	0.5	4.1
Footwear, Rubber	217.1	0.3	4.8
Fuel Oil, No. 2 (2/73 = 100)	699.1	(0.6)	21.6
Gasoline	641.6	(1.0)	34.0
Glass Containers	305.0	3.5	15.0
Gypsum Products	249.5	(0.9)	(2.3)
Hand Tools	286.9	0.6	14.5
Hand Tools, Power Driven	197.1	1.1[2]	11.4
Hardware	230.5	0.1[2]	7.5
Industrial Chemicals	329.0	0.9[2]	15.2
Kerosene (2/73 = 100)	683.2	0.5	24.2
Lumber	319.2	(2.3)%	(13.8)%
Mixed Fertilizers	243.6	(0.2)	13.2
Motor Vehicle Parts	258.1	0.4	11.4
Natural Gas	915.1	2.8[2]	30.0
Nonferrous Wire and Cable	214.9	0.3	8.3
Paint Materials	279.5	0.2	10.2
Paper	262.5	1.4	10.0
Paperboard	241.0	0.8	14.1
Pesticides	375.3	0[2]	8.4
Photographic Supplies	258.2	0	43.8
Plastic Constr. Prod. (12/69 = 100)	151.3	(4.1)	(0.5)
Plastic Film (12/70 = 100)	195.1	0	6.9
Plumbing Fixtures & Brass Fittings	250.6	0	12.1
Plywood	253.1	(0.2)	(0.4)
Portland Cement	308.9	(0.2)	8.2
Prepared Paint	239.6	0[2]	15.9
Protective Clothing (6/78 = 100)	126.0	0[2]	3.3
Refractories	274.1	1.0	12.1
Residual Fuel	939.0	(1.3)	17.2
Sand, Gravel & Crushed Stone	245.4	2.4	15.4
Sanitary Papers & Health Prod.	336.9	0.5	16.7
Soaps & Synthetic Detergents	223.5	0.6[2]	10.6
Sporting Goods	202.0	0.2	11.5
Structural Clay Products	233.4	1.4[2]	5.6
Tires and Tubes	244.7	2.0	12.1
Tractor Parts	183.1	0.1[2]	5.7
Transformers & Power Regulators	192.3	1.5[2]	15.7
Valves & Fittings	293.4	0.7	10.8
Wiring Devices	272.2	0.2	8.5

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted

FEBRUARY 1981

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public works engineering and management

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Sewage Lift Station Design Guidelines

How to avoid a pre-engineered nuisance

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On the cover: Extending 40 feet below ground level in Mobile, Alabama, the Econchate Wastewater Treatment Plant Pumping Station houses four 125-horsepower pumps, each capable of moving 5000 gallons per minute. Betz-Converse-Murdoch (BCM) Southern Group of Mobile designed the facility. For handling smaller volumes of wastewater, municipalities often select packaged pumping stations. Guidelines for avoiding problems with these pre-engineered installations are the subject of the feature that starts on page 37.

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Letters to the Editor

Equipment line moved, not dropped

An article in your November issue indicated that FMC had completely dissolved its Environmental Equipment Division and gone out of the wastewater equipment business. In fact, the product lines you named that we had ceased to manufacture — aeration, package plant and sludge processing equipment sold under the Chicago Pump name and sludge and grit collectors, screens, clarifiers, thickeners and screw pumps sold under the Link-Belt name — have been transferred to our Material Handling Systems Division in Colmar, Pennsylvania.

HOMER A. HASWELL
Marketing Communications
FMC Corporation
Itasca, Illinois

At least it's right side up

Being formerly associated with the Inter-American Geodetic Survey as a cartographer and now with a consulting engineering firm specializing in water systems, I was interested in your picture of Montgomery College's water storage tank (December, 1980, p. 19).

If your photo faithfully represents what the astronauts saw, we plainly need to reorient our thinking on mapmaking. On the other hand, if this is what the painters painted, artistic license has expanded to new limits.

Seriously, it did brighten up the already interesting technical article. You may be assured that AMERICAN CITY & COUNTY does get read here. It provides a good balance between design and operations.

JOHN P. ARNOT, P.E.
McDonnell Proudfoot Associates
Toledo, Ohio

■ The earth appears to be a mirror image when seen from 20,000 miles if it is as shown in the December issue.

JERALD L. WHITFORD
Project Engineer
Associated Engineers, Inc.
Higginsville, Missouri

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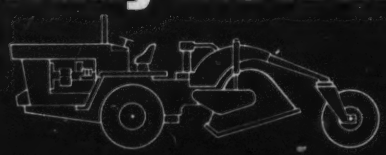

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76 **MUNICIPAL COST INDEXES**

On the cover: Unlike many items purchased by local governments, a piece of construction equipment — like this International Harvester tractor-loader-backhoe — may have a total lifetime ownership cost that exceeds its initial purchase price. To factor this anticipated expense into the purchasing process, some agencies now buy these machines using a system known as total-cost bidding or life-cycle costing. To find out more about this technique, turn to the lead feature on page 25.

Municipal Cost Indexes

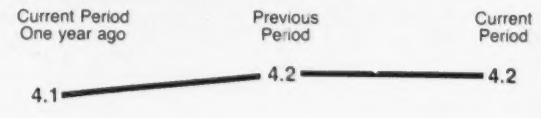
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 278.9 +1.6% +11.6%

Consumer Price Index	258.4	0.9%	12.6%
ACC Construction Cost Index	306.5	1.5	7.5
General Construction Materials	284.0	1.0	7.4
Motorized Equipment	253.4	0.2	11.1
Energy; Fuels and Power	775.0	5.8	31.1
Consumable Supplies	273.4	4.0	16.3
Producer Price Index	254.7	0.6	11.7

MUNICIPAL TREND TO WATCH

Long Term Security Issues, Billions of Dollars



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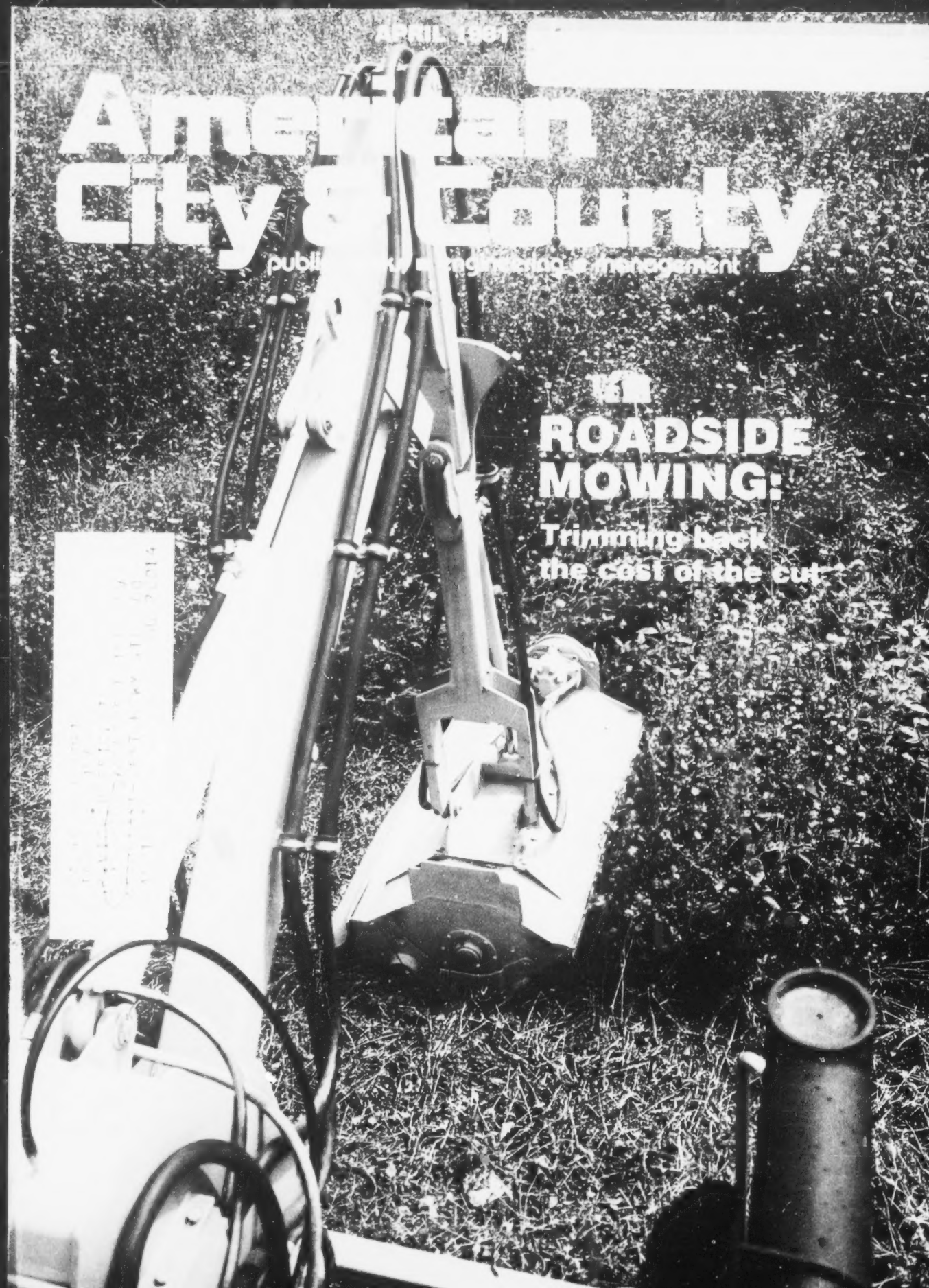

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On the cover: The smell of freshly cut grass, once as much a sign of summer as the scent of burning leaves was of autumn, may become endangered sensation. The cause is not, however, environmental regulations, but shrinking budgets. Highway agencies across the country are cutting mowing schedules and looking for techniques and equipment, such as this Schmidt flail-head boom-mower, to increase the efficiency of the remaining mowing operations. Turn to page 43 for details of these efforts.

ROADSIDE MAINTENANCE UPDATE

How to trim the cost of the cut

Because roadside mowing is expensive in its use of both manpower and fuel, highway departments are looking for more efficient ways to maintain their rights-of-way by balancing traditional mowing schedules against the damaging side effects of uncontrolled foliage.

By John O'Connor, Engineering Editor

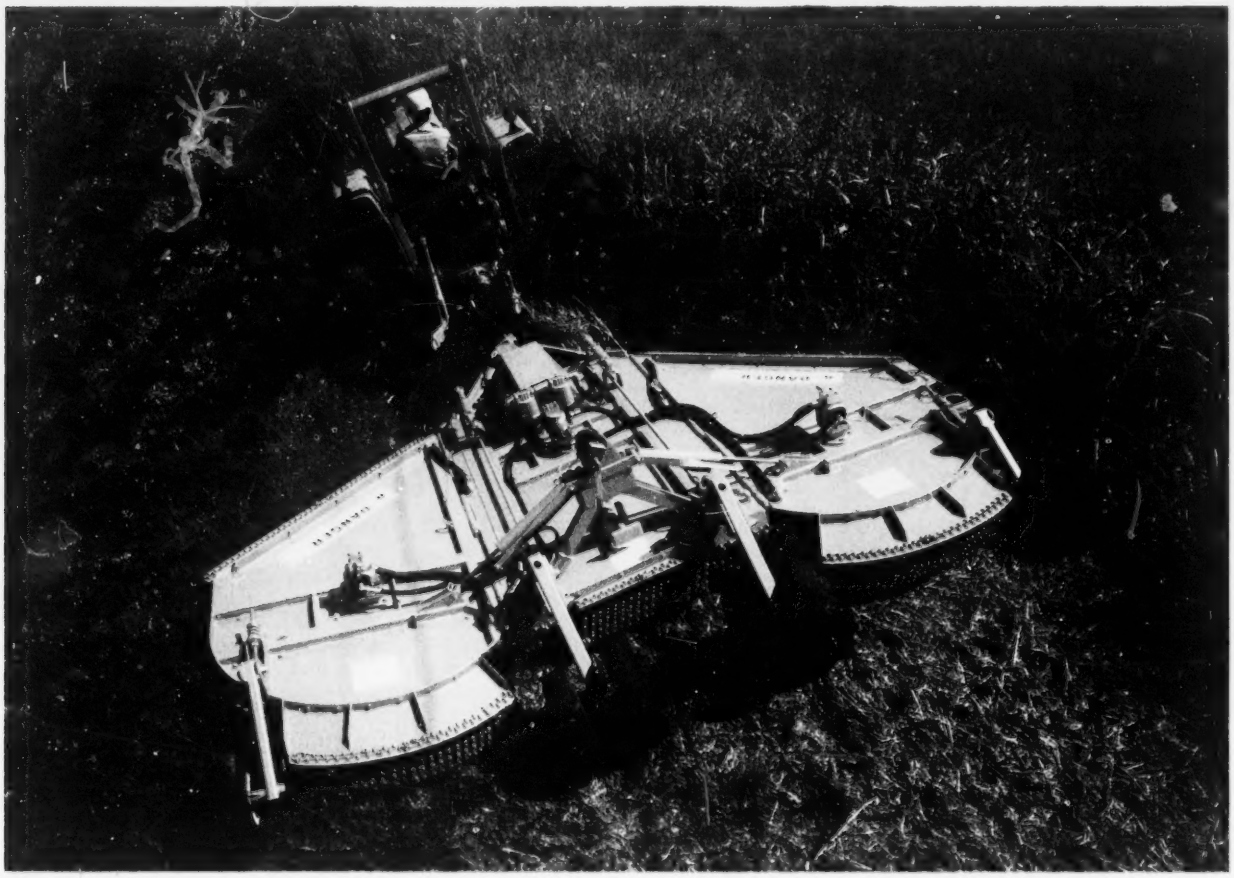
In the good old days of $0.299 per gallon gasoline, Americans took to the highways in summer, heeding the call of the open — and not-so-open — roads. On almost any trip, one familiar sight was the diamond-shaped orange sign that proclaimed, "Mowing operations ahead." Shortly thereafter, one or more tractors would come into view, moving slowly alongside the pavement while their operators manipulated rotary, flail, sickle-bar, or reel mowers to keep the vegetation manicured.

Today, the price of gasoline has drastically cut the number of people who casually decide to take a drive to "get out of the house." Those who are on the road may get the impression that the number of mowing operations has similarly declined.

They'd be right. Charles Edson, chairman of the Transportation Research Board's committee on roadside maintenance and assistant chief engineer of the New Jersey Department of Transportation's Construction and Maintenance Division, put it succinctly: "The big news in mowing is that people aren't."

According to Edson, there are two reasons. The obvious one is that few highway maintenance budgets include enough money to maintain the traditional mowing schedules. What's more, says Edson, right-of-way managers have found that mowing is unnecessary in many cases. If they apply a selective herbicide that kills plants that grow to undesirable sizes, they are finding that the remaining grasses often do not grow to unacceptable heights.

Confirming Edson's opinion is a study recently released by the Committee on Maintenance of the American Association of State Highway and Transpor-



Courtesy Terrain King Corp.

Steep slopes are dangerous, but more mowers may fall to budget cuts than to hills.

tation Officials (AASHTO). The committee report, *The Use of Herbicides in Roadside Maintenance*, indicates that in the past ten years, mechanical mowing has decreased in 38 states, while only six states report that they presently do more mowing than they did ten years ago.

Over the same period, nine state agencies have increased their use of growth retardants, and 28 have increased their use of herbicides. Only five states use less growth retardants, and eight, less herbicides.

The reason for the increased reliance on chemical, rather than mechanical, means of vegetation control can be expressed in a single word: cost. O. M. Pourciau of the Louisiana Department of Transportation and Development quantified his agency's cost analyses at last year's Transportation Research Board meeting. According to Pourciau, Louisiana spends a total of $12.64 to spray an acre twice each season. The cost of mowing the same area five times each season is $65.45.

In addition to direct cost, the size of the necessary workforce is a consideration. One Louisiana worker operating a swing-lock boomless sprayer can cover 150 acres per day. An employee operating a conventional mower can cut only about eight acres a day. To cover a given acreage with five mowings per year would require nearly 50 times the manpower that would be needed to spray it twice.

But if mowing can be eliminated, was it really necessary in the first place? There were — and are — a number of good reasons for mowing:

Safety. Left unmowed, roadside vegetation can grow to dimensions that reduce sight distances. Vehicles at intersections, driveways, or crossovers may be obscured or invisible; roadside warning signs may be concealed; even sight distances around curves may be shortened. The frequency of collisions will increase.

When roadside vegetation grows unattended, larger plants will become established. Bushes will encroach on the roadway, further reducing sight distances. Larger trees will grow to become collision hazards in themselves, and they will shade the pavement in winter, increasing required ice control efforts and the possibility of vehicular accidents.

Aesthetics. The Merritt Parkway in Connecticut is typical of the early, well-publicized scenic roadways that were called parkways. To live up to this designtion, maintenance supervisors had the rights-of-way mowed, trimmed, and manicured till they resembled golf courses. Because the public approved, this standard of roadside maintenance became the goal of many jurisdictions, even for roadways where the surroundings made this level of maintenance clearly unjustified.

Still, the visual appeal of a roadway, like that of most things, is a matter of taste. A few voices were raised against this level of maintenance. Later, the protesters were joined by environmentalists, who pointed out that roadside zones, if left in their natural states, could harbor indigenous plant and animal life that was being crowded out by suburban development and "fencerow to fencerow" planting of farmland.

Drainage. Highway construction includes provisions for conveying runoff along and across the right-of-way. Much of a drainage system consists of open ditches. If uncontrolled vegetation growth is allowed to block these ditches, the stability of the roadway may be endangered. In addition, adjacent property belonging to others may be flooded, and the agency subjected to lawsuit. Another hazard of impeded drainage is stagnant water, which provides breeding space for mosquitos and other pests.

Undesirable plants. A thick growth of grass discourages nuisance plants. These may be species that are poisonous to humans or animals. Even if the plants are not directly harmful, they may have undesirable effects, such as a short, vigorous growth period, during which they will shade and thereby kill the grass. Then the weeds die, leaving the soil exposed to erosion.

In view of these good reasons for mowing, a highway agency must carefully consider the ramifications of any decision to cut back on this important activity. One state highway department decided to plant crimson clover in the median of a highway, believing that it needed no maintenance. The clover grew to an unexpected height — some three feet — obscuring visibility at an intersection. A fatal collision resulted, and the highway department was held responsible in judgment in the death.

The use of chemicals, rather than mowing, for vegetation control is likely to increase, rather than decrease, the number of legal problems. Of the states responding to the AASHTO survey, at least a dozen reported problems with herbicides drifting off the right-of-way. Cases have been settled adversely for the involved states when crops and livestock were killed by herbicides that had been sprayed on the right-of-way.

The only logical approach to vegetation control, whether through mowing, chemical applications, or other measures, is to prepare a formal roadside management program that establishes objectives and the programs that will meet these objectives in the most economical way possible. At the state level, this approach is common. California, for example, recognized the importance of good roadside management when it categorized its maintenance activities by expenditure. Roadside maintenance proved to be the most expensive of the five maintenance activities: roadbed; roadside; structures; traffic control and public service; and auxiliary services.

Of these, roadside maintenance involved about 2360 person-years — roughly 41 percent of the total maintenance labor effort — and some $98 million per year. Just the landscaping item within the roadside maintenance budget is very close in cost to the total effort budgeted for the maintenance of all highway surfacing, all bridges, and all pumps. Proper management of an expenditure of this magnitude demands a formal plan.

In 1975, the state of Virginia set up ten test sites in different locations to study the variables involved in mowing. After studying these sites over sev-

Mowing by state highway agencies

State	Scope of responsibility Mileage	Scope of responsibility Acreage	Acres mowed	Ten-year mowing trend	Annual roadside budget Total ($)	Annual roadside budget Mowing (%)	Mowing cost per acre ($)
Alaska	6700	—	—	Increase	699,553	96	—
Alabama	11,212	99,115	201,747	Decrease	5,593,792	48	13.31
Arizona	6074	19,200	19,200	Decrease	1,808,517	30.1	28.35
Arkansas	15,000	90,000	300,000	Decrease	4,076,000	83	11.28
California	15,275	225,000	13,512	Decrease	8,532,000	19.92	125.78
Connecticut	4036	35,993	35,993	Decrease	2,725,000	2.0	1.51
Delaware	4602	—	8974	Increase	588,787	67.83	—
District of Columbia	1250	758	—	Decrease	—	—	—
Florida	12,795	108,700	528,000	Decrease	13,860,021	45.5	11.94
Idaho	5000	80,000	12,000	Decrease	700,000	23	13.42
Illinois	16,500	133,000	168,000	Decrease	4,350,000	68	17.61
Indiana	11,448	75,000	56,000	Decrease	5,534,000	57	56.33
Iowa	11,800	133,200	64,300	Increase	2,078,200	72.12	23.31
Kansas	10,150	150,000	50,000	Decrease	1,135,000	75	17.02
Kentucky	25,000	187,000	87,000	Decrease	6,200,000	60	42.76
Louisiana	16,914	123,607	95,082	Decrease	7,987,400	52	43.68
Maryland	6600	60,000	22,284	Decrease	2,318,341	53	55.14
Massachusetts	2800	60,000	5600	Decrease	800,000	81	115.71
Michigan	9400	175,000	45,000	Decrease	3,440,000	75	57.33
Minnesota	12,194	228,000	30,000	Decrease	4,500,000	—	—
Mississippi	21,710	95,250	188,208	Decrease	3,590,000	67	12.78
Missouri	32,000	765,800	285,000	Decrease	8,019,000	5	1.41
Montana	9283	140,000	20,000	Decrease	647,694	50	16.19
Nebraska	9836	152,500	40,963	Decrease	1,888,716	68	31.35
Nevada	5361	129,964	11,000+	Increase	506,117	53	24.39
New Hampshire	4150	—	9868	Decrease	1,294,687	60.1	78.85
New Jersey	2220	—	10,460	Decrease	2,128,710	55.9	113.76
New York	15,000	35,000	56,000	Decrease	3,000,000	27	14.46
North Carolina	75,903	276,478	202,478	Increase	12,622,929	55	34.29
North Dakota	7047	210,000	90,000	No change	825,000	75	6.88
Ohio	19,000	80,000	32,000+	Decrease	3,332,000	67	69.76
Oklahoma	12,000	200,000	85,000	Decrease	2,400,000	65	18.35
Oregon	7624	29,600	12,900	Decrease	2,104,000	6.3	10.28
Pennsylvania	45,000	300,000	75,000	Decrease	4,550,000	32.4	19.66
South Carolina	39,250	255,000	85,000	Decrease	6,901,241	62.8	50.99
South Dakota	9089	105,000	59,276	Decrease	796,936	57	7.66
Tennessee	9857	250,564	62,553	Decrease	5,708,494	73.6	67.17
Texas	180,000	1,000,000+	600,000	Decrease	22,000,000	—	—
Utah	5637	180,000+	8000	Decrease	824,214	56.2	57.90
Vermont	2590	—	5000	Decrease	1,023,833	54	110.57
Virginia	52,314	91,000	172,000	Decrease	9,084,862	—	—
Washington	7000+	110,000+	10,500	Decrease	4,036,941	15	57.67
West Virginia	33,300	29,996	20,181	Increase	3,016,557	48	71.75
Wisconsin	11,415	112,000	35,000	Decrease	3,350,000	63	60.30
Wyoming	6140	225,000	36,000	Decrease	1,425,000	27	10.69
Total	827,476	6,256,725	3,955,209	38 Decrease	218,687,542	—	—
Maximum	180,000	1,000,000	600,000	6 Increase	22,000,000	96	125.78
Minimum	1250	758	5000	1 No change	506,117	2	1.41
Average	18,338	156,418	91,981		3,440,593	49	27.10

Source: *The Use of Herbicides in Roadside Maintenance*, AASHTO Committee on Maintenance, November 1980

eral mowing seasons, the committee in charge of the project concluded that the state was mowing too often, cutting the grasses too short, and even mowing in some areas where no mowing was required. A corrective program was proposed:

- Mowing would not start before 1 June, nor before all fescue seedheads had grown to a minimum height of eight inches
- Mowing height would be changed from four inches to eight inches, with additional supports mounted on sicklebar and bushog mowers to maintain this height
- Wherever possible, areas characterized by weed problems would be treated with herbicides one week after mowing, for a distance of eight feet from the pavement edge
- The number of mowings would be reduced by scheduling no mowings after the initial mowing until the vegetation was 14 inches high
- Some of the money saved by reductions in mowing would be used to reseed and fertilize the area within eight feet of the pavement edge

In reporting on Virginia's program to last year's Transportation Research Board meeting, Marion Creech of Byrd, Tallamy, MacDonald and Lewis, Falls Church, Virginia, described a major difficulty. Operators who had been mowing at a height of four inches for many years were found to be very disinclined to raise their mowers to cut at the newly specified taller heights. Just issuing instructions and posting directives are insufficient to change this attitude. Adequate explanations for the change, along with supervision to ensure that it is followed, are necessary.

Labor problems resulting from a change in mowing standards do not arise in an agency that does not provide the labor for mowing. William Gere, operations engineer in the Office of Maintenance of the South Dakota Department of Transportation, reports that a significant portion of that state's right-of-way is mowed at no cost to the taxpayers. Adjoining landholders do the work in exchange for the hay that they harvest.

The department has approximately 110,000 mowable acres on its highway system. In 1978, some 65 percent of this acreage was mowed privately. As a safety measure, the state mows the median areas.

Florida tried mowing by contract, a concept that has produced savings in other categories of public works programs. It found that an area that had been mowed by the state DOT at a cost of $41,000 was done under contract for $21,000. Despite the magnitude of this cost reduction, the state plans to cut maintenance expenses still further by turning mowing responsibilities over to the Department of Corrections, which will have prison inmates do the work.

Still, whether private contractors or prisoners do the physical mowing, it is the highway department that is responsible for maintaining the roadside at the established standards. Perhaps the most cost-effective way to accomplish this is not to uniformly reduce mowing frequency, but to redefine the right-of-way into zones that require mowing and those that can be allowed to return to a more natural state. According to Creech, many motorists seem to like rustic-appearing roadsides. He cited as examples a number of garden clubs in the Shenandoah Valley of Virginia. Cutbacks in mowing there resulted in a profusion of roadside wildflowers that in earlier years had been cut before they bloomed.

Highway engineers have progressed greatly from the days when they considered the roadside to be only the area remaining after the pavement was laid, extending from the edge of the shoulder to the right-of-way fence. Today, the AASHTO subcommittee on maintenance has a recommended set of operating priorities that apply as much to the roadside as to the pavement: (1) Safety, (2) Preservation of the capital investment in the highway system, (3) Maintaining the operational characteristics of the roadway, and (4) Providing reasonable aesthetic qualities. They're good rules to follow. **ACC**

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Mower lowers the boom on tough vegetation

Not all mowing jobs involve just trimming the height of a well maintained stand of grass. When the vegetation is heavy brush and the terrain is steep riverbank, mowing takes on a whole new dimension.

This was the case in Lisle, Illinois, a village of 13,600 residents located about 35 miles west of Chicago. The village Board of Trustees told Streets Superintendent Joseph Novak to clean up the banks of the St. Joseph Creek, and to do it quickly.

"The village fathers gave us a very, very tight time schedule," said Novak. "They did not expect us to meet that schedule, but we beat it by 400 man-hours. It was unbelievable."

Although Novak had been with the village for ten years, he considered the project to be one of the toughest problems he had faced. With the help of creative employees, Novak solved it by mounting a two-section boom mower from Schmidt Engineering & Equipment Co., Ltd., of Milwaukee, Wisconsin, on a *Unimog*, an off-road implement carrier manufactured by Daimler-Benz, of West Germany. *Unimogs* are marketed in North America by Mercedes Benz.

The 80 cutters on the Schmidt flail-head mow a four-foot-wide swath. The two-section boom enables the operator to position it alongside the vehicle's rear tire, or to reach out as far as 23 feet. The cutters are effective on vegetation as heavy as small trees.

But that's only if they can get to them. One of Novak's employees noted that the *Unimog* could not be driven on part of the creek's levee because of some recently planted trees. With some apprehension, Novak had a ramp built, and the *Unimog* driven directly into the creek.

Although the water level was in excess of three feet — *Unimogs* are designed to operate in three feet of water — the vehicle and the Schmidt boom mower "did a fantastic job of cutting the undergrowth of heavy thornbushes, thick grass, and brush back from the water's edge," said Novak. "The driver just maneuvered the vehicle through the creek, and the mower head reached the top of the levee with no problem."

Novak has purchased a number of Schmidt attachments that allow him to convert the *Unimog* for use on different tasks. With the Schmidt quick-hitch attachment system, Novak can use the vehicle as a mower for part of a day, then convert it for use as a front-end loader, then as a street sweeper — and all in the same day! Novak also has in stock four Schmidt snowplows and a snowblower. Two of the plows can be mounted on vehicles other than the *Unimog*.

Regardless of the other attachments, the mower alone has proven its worth. Rapid growth increased the town's mowing responsibility from 100 to 400 acres and Novak was hard pressed to handle the increased workload until the village acquired the *Unimog*-Schmidt mower combination.

"Surprisingly enough," he says, "we now cover 400 percent more territory in only twice the time, and with fewer employees mowing. We're doing it because we have a much faster machine. I just don't know how else to explain it." ■

Municipal Cost Indexes

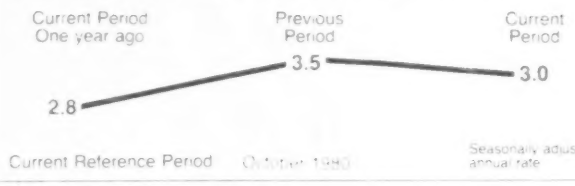
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967 = 100)

ACC MUNICIPAL COST INDEX 280.6 +0.6% +10.9%

Consumer Price Index	260.5	0.8%	11.7%
ACC Construction Cost Index	305.9	(0.2)	7.0
General Construction Materials	293.1	3.2	8.5
Motorized Equipment	254.4	0.4	9.5
Energy: Fuels and Power	792.1	2.2	27.0
Consumable Supplies	273.8	0.1	14.9
Producer Price Index	259.8	1.1	10.8

MUNICIPAL TREND TO WATCH

Water Supply Facility Construction, Billions of Dollars



CAPITAL EQUIPMENT 253.9 +1.2% +10.8%

Agricultural Machinery & Equip.	273.5	1.5%	10.1%
Air Conditioners (12/77 = 100)	126.0	0.7	7.6
Construction Machinery & Equip.	304.9	1.3	10.5
Electric Motors	261.9	2.5	6.1
Environmental Controls (6/80 = 100)	106.0	0[2]	—
Fans and Blowers (Ex. Portable)	308.8	0	9.8
Fluid Power Equipment	214.5	1.5[2]	15.1
Generators and Generator Sets	319.6	2.7[2]	27.1
Heating Equipment	215.4	1.3[2]	8.0
Industrial Material Handling Equip.	265.4	1.4[2]	9.5
Integrating & Measuring Inst.	189.2	0.4	7.9
Internal Combustion Engines	284.9	1.3%	12.3%
Motor Trucks, Light	239.7	2.0[2]	12.5
Motor Trucks, Heavy	265.7	1.5[2]	11.8
Office Machines	144.9	0.8[2]	4.8
Passenger Cars	199.4	1.0	8.2
Photographic Equipment	123.8	0	3.0
Pumps, Compressors & Equipment	307.6	1.0	13.7
Railroad Equipment	327.8	1.3	10.2
Refrig. Compressors (12/77 = 100)	127.8	0[2]	7.2
Switchgear, Switchboard Equip.	239.8	2.0	9.8

INDUSTRIAL COMMODITIES 296.6 +1.4% +10.6%

Abrasive Products	263.5	0.8%	11.3%
Apparel	178.6	0.9	7.9
Asphalt Roofing	404.1	2.4	13.3
Building Paper and Board	219.1	0	17.7
Coal	477.5	0.4	4.0
Commercial Furniture	246.1	1.5[2]	8.5
Concrete Products	285.6	2.8	7.6
Diesel Fuel (2/72 = 100)	741.9	4.4[2]	24.8
Drugs and Pharmaceuticals	219.6	2.5[2]	11.1
Electric Lamps/Bulbs	259.1	(0.1)[2]	6.9
Electric Power	341.7	1.1	17.6
Electronic Components	163.6	1.0	11.9
Fabricated Structural Metal	283.0	1.4	9.3
Finished Lubricants	326.8	0.7[2]	18.5
Finished Steel Products	321.1	3.1	10.0
Flat Glass	203.9	0.4[2]	6.8
Floor Coverings	172.3	1.2	8.4
Footwear	238.6	0.6	4.1
Footwear, Rubber	217.8	0.1	5.2
Foundry Products	321.7	1.4	7.8
Fuel Oil, No. 2 (2/73 = 100)	761.1	5.3	27.6
Gasoline	657.7	1.6	25.9
Glass Containers	311.5	0	13.6
Gypsum Products	259.6	2.7	1.6
Hand Tools, Power Driven	134.9	1.4[2]	11.1
Hardware	252.5	1.2[2]	10.6
Industrial Chemicals	342.8	2.5[2]	13.2
Kerosene (2/73 = 100)	739.0	5.0	29.7
Lumber, Softwood	353.4	(0.6)	(0.6)
Lumber, Hardwood	250.0	0.6%	(4.3)%
Millwork	273.6	0.1	7.7
Mixed Fertilizers	251.3	1.8	8.9
Motor Vehicle Parts	303.6	1.0	28.6
Natural Gas	967.3	1.4[2]	31.3
Nonferrous Wire and Cable	211.1	(1.4)	0.2
Paint Materials	283.1	0.8	8.9
Paper	271.1	0.4	10.4
Paperboard	251.1	4.1	13.2
Pesticides	375.3	0[2]	8.4
Photographic Supplies	270.9	0.2	39.3
Plastic Constr. Prod. (12/69 = 100)	153.5	(0.1)	2.6
Plastic Film (12/70 = 100)	193.5	(0.1)	4.3
Plumbing Fixtures & Brass Fittings	255.5	0.4	9.8
Plywood	251.1	(4.7)	5.4
Portland Cement	319.1	3.8	4.3
Prepared Paint	243.3	0.7[2]	9.0
Refractories	283.5	3.4	14.1
Residual Fuel	1201.5	3.5	27.1
Sand, Gravel & Crushed Stone	254.4	2.6	12.5
Sanitary Papers & Health Prod.	343.4	0	15.0
Soaps & Synthetic Detergents	227.2	0[2]	8.1
Sporting Goods	207.8	1.1	8.9
Structural Clay Products	240.0	2.5[2]	4.5
Tires and Tubes	240.5	(1.7)	6.8
Tractor Parts	185.7	1.2[2]	6.1
Transformers & Power Regulators	192.6	0.8[2]	13.1
Valves & Fittings	297.7	0.4	9.2
Wiring Devices	283.0	2.1	11.1

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted

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108 **MUNICIPAL COST INDEXES**

On the cover: One knowledgeable construction machinery salesman recently maintained that more earth was being moved at landfills than at all U.S. construction sites. As environmental concerns push more and more communities into excavating and placing more cover material atop wastes, earthmoving machinery without question becomes a major concern of every landfill manager. The article on page 39 provides guidelines for selecting the best machine for a particular site — and for operating and maintaining it for maximum economy and productivity. (Cover photo courtesy of John Deere)

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Municipal Cost Indexes

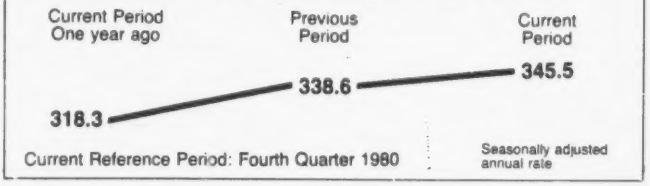
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 282.6 +0.7% +10.3%

Consumer Price Index	263.2	1.0%	11.3%
ACC Construction Cost Index	306.1	0.1	7.0
General Construction Materials	294.5	0.5	7.7
Motorized Equipment	263.6	3.6	13.3
Energy; Fuels and Power	808.6	2.1	24.2
Consumable Supplies	277.4	1.3	14.0
Producer Price Index	262.4	1.0	10.4

MUNICIPAL TREND TO WATCH

Purchases of Goods and Services, Billions of Dollars



Current Reference Period: Fourth Quarter 1980

Seasonally adjusted annual rate

CAPITAL EQUIPMENT 256.3 +0.9% +11.2%

Agricultural Machinery & Equip.	277.2	1.4%	10.9%
Air Conditioners (12/77 = 100)	126.3	0.2	6.9
Construction Machinery & Equip.	308.4	1.1	10.8
Electric Motors	265.5	1.4	7.4
Environmental Controls (6/80-100)	102.9	(2.9)	–
Fans and Blowers (Ex. Portable)	308.8	0	8.8
Fluid Power Equipment	214.5	0[2]	12.0
Generators and Generator Sets	320.4	0.3[2]	22.2
Heating Equipment	216.1	0.3[2]	6.7
Industrial Material Handling Equip.	265.9	0.2[2]	8.3
Integrating & Measuring Inst.	189.8	0.3	5.3
Internal Combustion Engines	285.6	0.2%	11.9%
Motor Trucks, Light	239.6	0	13.2
Motor Trucks, Heavy	269.4	1.4	13.4
Office Machines	145.8	0.6[2]	5.2
Passenger Cars	199.2	(0.1)	9.2
Photographic Equipment	126.9	2.5	3.7
Pumps, Compressors & Equipment	312.9	1.7	14.6
Railroad Equipment	334.4	2.0[2]	11.7
Refrig. Compressors (12/77 = 100)	127.8	0[2]	17.2
Switchgear, Switchboard Equip.	242.9	1.3	7.5

INDUSTRIAL COMMODITIES 299.5 +1.0% +9.5%

Abrasive Products	268.7	2.0%[2]	11.1%
Apparel	179.3	0.4	7.5
Asphalt Roofing	389.3	(3.7)	4.5
Building Paper and Board	225.2	2.8	17.5
Coal	480.8	0.7	4.6
Commercial Furniture	251.2	2.1[2]	8.6
Concrete Products	286.6	0.4	7.5
Diesel Fuel (2/72 = 100)	788.5	6.3[2]	23.5
Drugs and Pharmaceuticals	222.1	1.1[2]	11.7
Electric Lamps/Bulbs	264.5	2.1[2]	7.7
Electric Power	345.4	1.1	15.4
Electronic Components	164.1	0.3	9.5
Fabricated Structural Metal	285.6	0.9	10.0
Finished Lubricants	331.2	1.3[2]	14.8
Finished Steel Products	321.3	0.1	9.8
Flat Glass	204.3	0.2[2]	7.0
Floor Coverings	172.4	0.1	8.8
Footwear	240.8	0.9	5.6
Footwear, Rubber	218.5	0.3	5.5
Foundry Products	321.7	0	6.2
Fuel Oil, No. 2 (2/73 = 100)	815.1	7.1	27.4
Gasoline	684.3	4.0	22.4
Glass Containers	311.5	0	13.6
Gypsum Products	257.3	(0.9)	(1.9)
Hand Tools, Power Driven	136.7	1.3[2]	12.6
Hardware	256.0	1.4[2]	11.1
Industrial Chemicals	349.4	1.9[2]	13.5
Kerosene (2/73 = 100)	784.5	6.2	29.5
Lumber, Softwood	348.2	(1.5)	(4.1)
Lumber, Hardwood	250.3	0.1%	(3.7)%
Millwork	273.8	0.1	6.1
Mixed Fertilizers	260.4	3.6	9.7
Motor Vehicle Parts	311.2	2.5	30.0
Natural Gas	967.4	0[2]	24.0
Nonferrous Wire and Cable	209.6	(0.7)	(9.1)
Paint Materials	286.4	1.2	8.7
Paper	273.1	0.8	10.5
Paperboard	253.2	0.9	13.2
Pesticides	375.3	0[2]	8.4
Photographic Supplies	272.0	0.4	(7.5)
Plastic Constr. Prod. (12/69 = 100)	153.4	(0.1)	2.3
Plastic Film (12/70 = 100)	194.8	0.6	5.8
Plumbing Fixtures & Brass Fittings	259.0	1.4	9.4
Plywood	248.6	(1.0)	2.1
Portland Cement	319.0	0	4.3
Prepared Paint	246.9	1.5[2]	10.6
Refractories	294.4	3.8	17.2
Residual Fuel	1237.4	3.0	27.6
Sand, Gravel & Crushed Stone	258.0	1.4	12.8
Sanitary Papers & Health Prod.	347.3	1.1	13.2
Soaps & Synthetic Detergents	228.3	0.5[2]	8.0
Sporting Goods	209.5	0.8	8.3
Structural Clay Products	240.4	0.2[2]	4.1
Tires and Tubes	243.1	1.1	5.0
Tractor Parts	198.1	6.7[2]	11.7
Transformers & Power Regulators	193.9	0.7[2]	11.4
Valves & Fittings	300.4	0.9	9.1
Wiring Devices	286.5	1.9	12.1

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted

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JUNE 1981

American City & County

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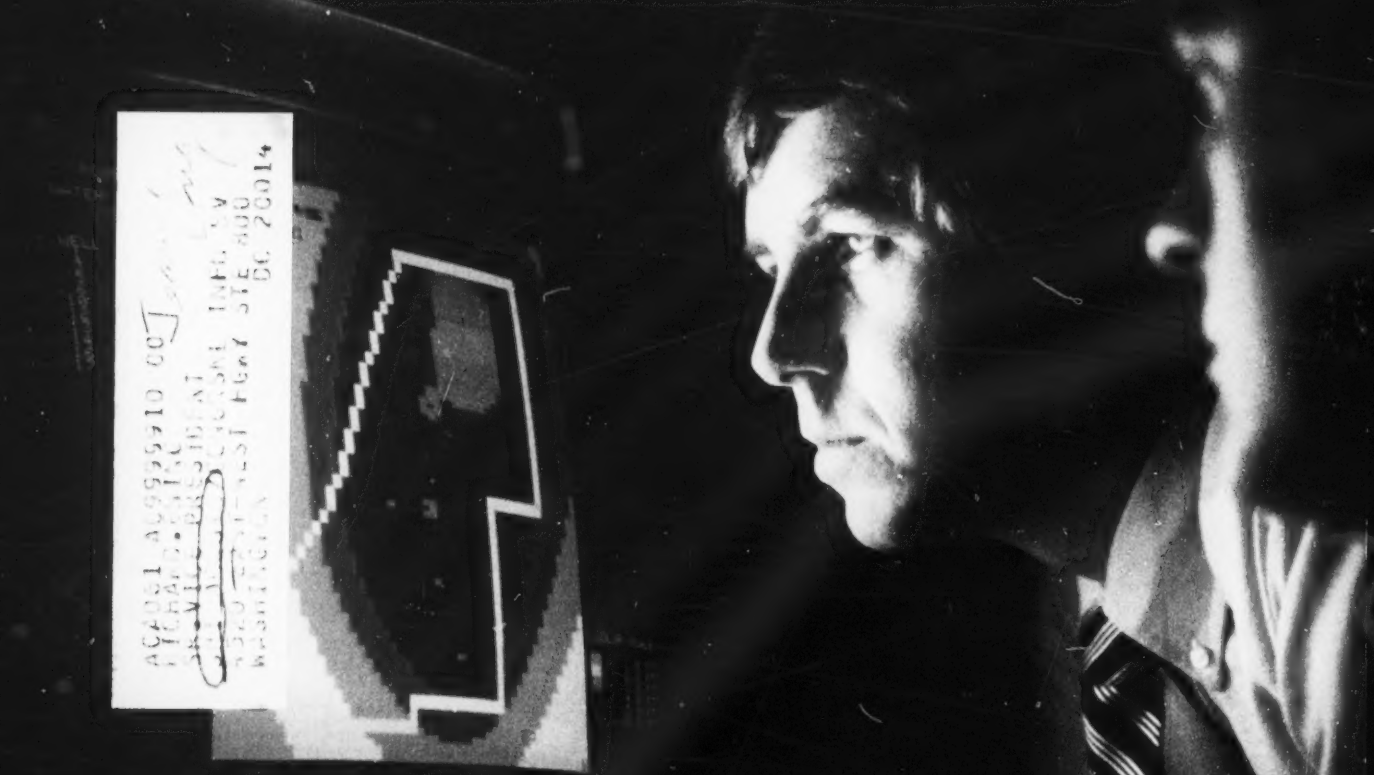

WATER TECHNOLOGY:

Computer monitors Tampa Bay water supply

Plus! 1981 Water Pipe Survey

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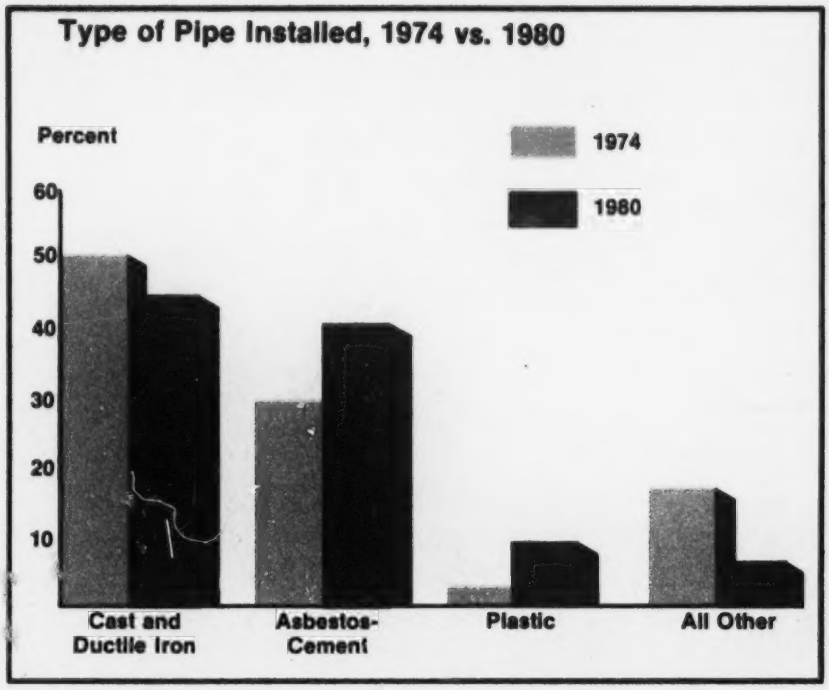
114 MUNICIPAL COST INDEXES
Public building costs rise $3.0 billion in a year

On the cover: An engineering first, the West Coast Regional Water Supply Authority's (Tampa Bay, Florida) computer monitoring/control system provides a real-time view of well field serving this water-short area so that individual well drawdowns don't exceed regulatory limits and operator can begin harder pumping for other wells instantaneously. Winner of the 1981 Engineering Excellence Award, this Camp, Dresser McKee project is described in detail in the article starting on page 33 (Aronson Photographics photo).

Cost, not material, shifting pipe choice

Since 1975, the cost of pipe has become more important to water utility superintendents than whether it's ductile iron, plastic, or asbestos-cement. But is the trend really a trend?



What type of pipe is most often specified for water main use? Ask any water superintendent, and you'll probably hear it's ductile iron. That's what we did for our 1981 pipe survey, and that's just what we heard. However, that's not all we heard.

The 1981 AMERICAN CITY & COUNTY Water Main Pipe Survey found that the percentage of cast and ductile iron pipe in the ground had dropped from 78.2 percent five years ago to 75.4 percent today. Comparing single-year pipe installations (1974 vs. 1980) showed a more pronounced fall-off: while 50.6 percent of the pipe installed in 1974 was iron, only 44.8 percent of the pipe installed in 1980 was cast or ductile iron.

And, while all other types of pipe showed insignificant gains or losses over the six-year period, asbestos-cement (A/C) pipe jumped from 10.8 percent of pipe in place in 1975 to 13.9 percent in 1980.

Again, single-year installations provide a more dramatic comparison. While 29.8 percent of all pipe installed in 1974 was asbestos-cement, in 1980 A/C pipe made up 40.4 percent.

Plastic pipe, forecast for strong growth six years ago, did not measure up to its projections. Even though plastic pipe accounted for nearly six percent more installed miles in 1980 as compared to 1974, it was reported as only one percent more of in-place pipe mileage, not a significant gain.

Still, when asked what type of pipe would be the predominant choice for use in 1981, water superintendents came out strongly for ductile iron. Sixty-five percent of them said they would specify it, either exclusively or at least in certain pipe sizes. Fifteen percent said they would use A/C pipe, while 11 percent would specify plastic pipe for new construction.

The fact that ductile iron remains the choice of the bulk of the nation's water superintendents offers a clue about the nature of A/C pipe's popularity, a clue which the survey data and superintendents themselves corroborate.

The South Central and Western states proved to be bastions of A/C pipe use. In those regions, there was a far greater proportion of A/C pipe in place than in other regions. Also, a greater proportion of pipe installed in 1980 was A/C, and more superintendents there said they would specify the pipe this year than in other regions. And that regional trend was even more specific. In the West, where a full 37 percent of the respondents said they would choose A/C pipe for this year's construction, Washington or Oregon indicated no such preference. In the South Central region, where 26 percent of the superintendent respondents liked A/C pipe, only superintendents in the State of Texas would go on record as saying they would specify A/C pipe this year.

Sun Belt likes A/C

These Sun Belt areas of the country are where A/C pipe got its foothold in the postwar economy and where the most growth continues to take place. Recognition of this fact sheds light on another finding of the survey. While a full 70 percent of superintendents nationwide installed ductile iron pipe last year, it made up only 38 percent of total mileage installed. Asbestos-cement pipe, by contrast, made up a full 40 percent of the pipe installed in 1980, yet it was put in by only 23 percent of the responding utilities. The discrepancies indicate that A/C pipe, where it is being installed, is being laid in greater quantities, probably in parts of the country where system expansion is the order of the day.

Superintendents in the South Central and Western states told ACC they would choose A/C pipe over ductile iron because, in smaller diameters, A/C was as much as 50 percent less expensive per foot than ductile iron. They also noted that it was easier to tap than iron pipe, which enhanced its suitability for smaller-diameter installations. In larger diameters, however, the strength of ductile iron improved iron pipe's competitive position among most superintendents contacted. Several noted that they would specify A/C pipe for diameters up to 12 inches, and then require ductile iron. Still, South Central and Western superintendents felt the use of A/C pipe was necessary because of soil electrolytic conditions, which tended to corrode iron pipe rapidly.

Nationally, there was a slight shift to larger diameter pipe for main use. Roughly two percent less pipe was reported to be smaller than 12 inches in diameter in 1980 than six years ago. This finding corroborated a U.S. Department of Commerce study made three years ago, which showed a "gradual" annual percentage increase in the use of pipe 14 inches in diameter or

Regional results, 1981 Water Pipe Survey

Region	Northeast	Southeast	North Central	Great Plains	South Central	West	National average
Water pipe in place by type of pipe, %							
Cast and ductile iron	93.0	73.6	94.7	66.9	80.4	59.0	75.3
Asbestos-cement	3.7	11.1	1.1	20.6	15.2	22.9	13.9
Steel	1.0	6.8	0.5	1.6	0.8	11.8	4.6
Reinforced concrete	2.0	1.1	2.5	4.1	1.6	2.5	2.5
Plastic	0.1	6.8	0.4	2.3	1.1	0.7	1.5
All other	0.1	0.6	0.8	4.4	0.0	3.1	2.0
Water pipe in place by size of pipe, %							
Less than 6 inches	10.9	24.3	5.3	21.4	15.3	14.8	14.6
6–12 inches	71.8	68.3	81.6	67.3	76.0	70.8	72.3
13–24 inches	11.5	6.3	8.0	7.7	7.1	8.3	8.4
More than 24 inches	5.7	1.1	5.0	3.6	1.5	6.1	4.6
Type of pipe preferred by respondents, %							
Cast iron	4.8	3.5	4.6	—	—	—	2.4
Ductile iron	80.6	57.1	81.5	38.4	74.2	46.9	64.6
Asbestos-cement	4.8	10.7	3.1	25.6	9.7	36.4	15.5
Steel	—	—	—	—	—	6.1	1.4
Prestressed concrete	3.2	—	4.8	12.8	3.2	—	3.8
Plastic	6.4	25.0	3.1	23.1	12.9	10.6	11.3
All other	—	3.5	3.1	—	—	—	1.0

larger. Such findings may reflect the replacement of hastily installed undersized mains — put in to meet rapid suburban growth in the material- and money-short post-war years — with new mains sized for both water service and fire protection needs. "People can afford to be a little liberal in sizing pipe today because the pipe itself is no longer the big cost item in installation," one consultant told ACC. "Labor is."

In 1981, the survey data revealed, utilities will put in only a little more pipe than they did last year. However, some five percent fewer of them will put in five or more miles of pipe than they did in 1980, an indication that replacement, not expansion, will provide the impetus. Nevertheless, the ratio of replacement pipe to new pipe did not change appreciably; the 1981 survey showed replacements accounted for about 21 percent of all pipe installed in a year.

Regional perspectives

The 1981 ACC water pipe survey will provide no fodder for those who would like to rebut the Frostbelt-Sunbelt argument. The data seem to fit, almost disturbingly well, the image of the North as slow growing and conservative and the image of the South and West as booming and progressive. And the Great Plains, as one might expect, emerges as the great middler.

The Northeast reported the smallest percentage of plastic pipe in place and installed the smallest percentage of it in 1980, compared to other regions. Proportionately fewer utilities used plastic pipe in the Northeast than in other regions, and here also was recorded the weakest preference for reinforced concrete pipe. Northeast data showed other features befitting the region's popular image:

- The average Northeastern utility put in the fewest miles of pipe of all regions in 1980 (2.6 miles) and will put in the fewest in 1981 (2.9 miles);
- The region put in the largest proportion of its 1980 pipe as replacement pipe (43.3) and will do so again in 1981 (51.6 percent);
- The Northeast contained the largest proportion of utilities that put in less than one mile of pipe in 1980 (39.6 percent) and said they would put in less than one mile in 1981 as well (28.0 percent).

The Southeast, by contrast, reported the largest percentage of in-place and 1980 installed pipe mileage to be plastic pipe. It also showed the strongest preference for plastic, with a full 25 percent of responding utilities saying they'll use plastic for 1981 jobs. Of its total 1980 and 1981 installations, the Southeast was the region with the largest percentage of new pipe, and no util-

Population results, 1981 Water Pipe Survey

Water pipe in place by type of pipe, %

Customers served	25-49,999	50-99,999	100-249,999	250-499,999	500,000+	National average
Cast and ductile iron	83.3	78.2	78.0	63.6	72.8	75.4
Asbestos-cement	9.0	13.5	10.7	27.0	14.4	13.9
Steel	3.2	3.7	3.8	4.0	6.5	4.6
Reinforced concrete	1.6	2.2	3.0	4.1	1.5	2.4
Plastic	1.5	1.5	2.9	0.5	0.4	1.5
All other	1.4	0.9	1.5	0.9	4.4	2.2

Water pipe in place by size of pipe, %

Less than 6 inches	13.6	14.1	18.0	13.7	11.0	14.4
6–12 inches	76.5	75.0	67.8	70.6	75.5	72.5
13–24 inches	8.8	8.2	9.4	7.4	7.4	8.3
More than 24 inches	1.1	2.7	4.7	8.3	6.0	4.7

Type of pipe preferred by respondents, %

Cast iron	2.4	3.0	2.7	—	—	2.4
Ductile iron	68.2	66.7	61.6	53.3	57.9	64.6
Asbestos-cement	11.8	20.2	10.9	20.0	21.0	15.5
Steel	1.2	—	2.7	—	5.3	1.4
Reinforced concrete	1.2	1.1	6.8	13.3	10.5	3.8
Plastic	15.3	8.1	13.7	6.7	5.3	11.3
All other	—	1.1	1.4	6.7	—	1.0

ity there put in less than a mile of pipe in 1980. In fact, 50 percent of them put in more than ten miles of pipe last year. Of all regions, it had the smallest amount of in-place pipe larger than 12 inches and the greatest amount of pipe with a diameter less than six inches.

The North Central region had the highest proportion of cast or ductile iron pipe in-place, and correspondingly, the smallest proportion of A/C pipe both in place and installed last year. Here too resided the strongest preference for iron pipe and the weakest for both A/C and plastic pipe.

The South Central states put in the smallest proportion of iron pipe in 1980 and the largest proportion of A/C pipe of all regions. The average utility there put in far more miles of pipe in 1980 (26.2 miles) and will put in more (27.5 miles) this year than its peer in any other region. A greater proportion of its utilities will put in more than ten miles of pipe this year (46.4 percent) and did so last year as well (57.7 percent). The region shows the weakest preference for iron pipe and the strongest for reinforced concrete.

The Great Plains utilities fall between the extremes, resembling their Northern peers in the relatively small amount of pipe installed but its Southern peers in use of A/C and plastic pipe.

The West had the smallest proportion of iron pipe (59.0 percent) and the largest proportion of A/C (22.9 percent) and steel pipe (11.8 percent) in the ground. It was also the region which showed the strongest preference for A/C pipe (37.3 percent) for 1981 construction.

Utility size correlations

Breaking down the pipe survey data by population size does not yield trends as consistent as does the regional data, aside from the predictable finding that the overall amount of pipe utilities installed last year and will install this year increases directly with population size.

Utilities serving **25,000 to 49,999** persons put in the largest proportion of iron pipe in 1980 and have the largest proportion in place (83.3 percent). These small cities also reported the smallest proportion of A/C pipe and steel pipe. However, the largest proportion of 1980 pipe installed by these utilities was plastic pipe (24.3 percent), and they showed the strongest preference for plastic pipe for 1981 installations (13.6 percent). Of all city sizes, the small cities reported the largest proportion of 1980 installations and 1981 projected use to be replacement pipe and the largest proportion of in-place pipe in the 6- to 12-inch range. In 1980, of all the population splits, they put in the smallest proportion of pipe greater than 24

inches in diameter and the largest below six inches.

In the **50,000 to 99,999** population size, the data show the fewest utilities with plastic pipe either in place or installed last year. This city size also showed the weakest preference for steel pipe, with none of the responding utilities indicating that they would be specifying it for this year's jobs.

The **100,000 to 249,999** population group contained these utilities where the largest proportion of in-place pipe was reported to be plastic (2.9 percent). These utilities also installed the largest proportion of reinforced concrete pipe in 1980 (8.5 percent). Of all city sizes, the largest proportion of both pipe under six inches in diameter and in the 13- to 24-inch range was found in these cities. And in 1980 these utilities put in the largest proportion of large pipe (above 24 inches in diameter) of all population sizes.

Utilities serving large cities from **250,000 to 499,999** persons had the smallest proportion of iron pipe in place and the largest of both A/C and reinforced concrete. Utilities serving these cities put in the largest proportion of their 1980 pipe in A/C and the least in plastic pipe. And they put in more new pipe as a proportion of total mileage installed in 1980 and will do so again in 1981. These utilities showed weakest preference for iron pipe (53 percent) and the strongest for reinforced concrete (13 percent).

The largest cities, with **500,000 persons and more,** have the largest proportion of steel pipe in place and installed the largest proportion in 1980. They also have the smallest percentage of plastic pipe in-place and show the weakest preference for this material. Large-city utilities installed the smallest proportion of iron pipe in 1980 of all city sizes but put in the largest proportion of 13- to 24-inch pipe last year. These cities show the strongest preference for both asbestos-cement and steel pipe. Iron pipe generally became a smaller proportion of in-ground pipe as population increased.

Overall, the survey appeared to reflect the influence of tightening budgets on the nation's water systems. It may also mirror, as one pipe manufacturer said, "a period of time where something's happening but hasn't finished happening yet." He and some superintendents noted that the recent but so far unsubstantiated public health concerns about A/C pipe may hurt its growth in years to come — and may finally bring to plastic pipe the growth that industry experts have been predicting since plastic's entry into the water pipe marketplace. **ACC**

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About the 1981 Water Pipe Survey

Distribution supervisors for utilities serving populations of 25,000 or more persons were sent a page-long survey in January of this year, and follow-up mailing was made in the middle of February. Of the 671 utilities surveyed, 254 responded with valid questionnaires, for a response rate of nearly 38 percent.

By region, response rates varied from a low of 25 percent from Southeastern utilities to a high of 51 percent from Great Plains water systems. Cities that responded to the survey ranged in size from 25,000 (Kingston, New York; Wakefield, Massachusetts; Aberdeen, South Dakota; and Springfield, Oregon) to 3.4 million in Los Angeles. Quantities of pipe reported in-place ranged from 60.7 miles in Hawthorne, California, to nearly 7000 miles in Los Angeles' system.

A full 55 percent of the Great Plains utilities that responded were small systems serving 25,000 to 49,999 persons. Only 19 percent of responding Western utilities were this small. None of the responding Great Plains systems served 500,000 persons or more; only 17 percent of the South Central region's utilities that answered the questionnaire served that large a population.

The survey elicited responses from every state except South Carolina, Oklahoma, Idaho, New Mexico, and the District of Columbia. California superintendents received 77 questionnaires, more than their peers in other states, and 34 of them were returned. The single utilities surveyed in Vermont, Nevada, Alaska, and Hawaii all sent in valid responses.

Four utilities serving populations of 1.0 million persons or more returned valid questionnaires. These were combined with returns from cities of 500,000 or more. ■

Municipal Cost Indexes

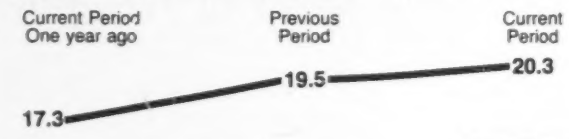
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 284.7 +0.7% +9.8%

Consumer Price Index	265.1	0.7%	10.6%
ACC Construction Cost Index	306.4	0.1	6.1
General Construction Materials	295.4	0.3	7.4
Motorized Equipment	264.3	0.3	13.3
Energy; Fuels and Power	843.2	4.3	26.7
Consumable Supplies	280.9	1.3	14.8
Producer Price Index	265.3	1.3	11.4

MUNICIPAL TREND TO WATCH

Public Building Construction, Billions of Dollars



Current Reference Period: December 1980

Seasonally adjusted annual rate

CAPITAL EQUIPMENT 257.8 +0.7% +11.2%

Agricultural Machinery & Equip.	278.7	0.7%	11.3%
Air Conditioners (12/77 = 100)	126.3	0	7.0
Construction Machinery & Equip.	311.3	0.9	11.8
Electric Motors	266.1	0.6	8.6
Environmental Controls (6/80-100)	103.4	0.5	—
Fans and Blowers (Ex. Portable)	312.1	1.2	9.9
Fluid Power Equipment	215.0	0.5[2]	11.9
Generators and Generator Sets	320.5	0.1[2]	14.3
Heating Equipment	217.6	0.7[2]	7.7
Industrial Material Handling Equip.	269.3	1.5[2]	9.2
Integrating & Measuring Inst.	192.5	1.6	6.8
Internal Combustion Engines	290.2	1.6%	12.6%
Motor Trucks, Light	239.7	0	13.2
Motor Trucks, Heavy	268.8	(0.2)	13.6
Office Machines	146.1	0.2[2]	4.7
Passenger Cars	198.5	0	8.8
Photographic Equipment	129.2	2.0	5.5
Pumps, Compressors & Equipment	315.2	0.5	13.8
Railroad Equipment	335.8	0.6[2]	11.5
Refrig. Compressors (12/77 = 100)	127.8	0[2]	4.7
Switchgear, Switchboard Equip.	243.1	0.1	7.2

INDUSTRIAL COMMODITIES 304.7 +1.3% +8.1%

Abrasive Products	271.3	1.1%[2]	11.8%
Apparel	180.1	0.6	7.0
Asphalt Roofing	400.7	2.3	3.4
Building Paper and Board	227.3	(0.3)	14.4
Coal	481.3	0.4	4.5
Commercial Furniture	253.2	0.8[2]	8.8
Concrete Products	286.9	0.5	6.8
Diesel Fuel (2/72 = 100)	848.9	7.7[2]	26.2
Drugs and Pharmaceuticals	222.1	0[2]	11.7
Electric Lamps/Bulbs	265.9	0.7[2]	8.6
Electric Power	350.4	(0.2)	14.6
Electronic Components	166.4	1.4	10.8
Fabricated Structural Metal	289.4	1.2	10.1
Finished Lubricants	335.2	1.2[2]	16.1
Finished Steel Products	327.4	2.0	11.3
Flat Glass	204.8	0.2[2]	7.0
Floor Coverings	174.0	0.9	8.3
Footwear	240.5	(0.5)	3.8
Footwear, Rubber	219.2	0.6	5.9
Foundry Products	321.9	(0.6)	5.3
Fuel Oil, No. 2 (2/73 = 100)	885.9	9.0	31.0
Gasoline	737.6	7.5	21.9
Glass Containers	311.5	0.8	13.4
Gypsum Products	257.6	0.1	(3.7)
Hand Tools, Power (12/76=100)	138.9	1.6[2]	12.7
Hardware	256.5	0.5[2]	17.7
Industrial Chemicals	352.5	0.9[2]	13.5
Kerosene (2/73 = 100)	851.4	8.1	31.1
Lumber, Softwood	343.9	(2.5)	(3.8)
Lumber, Hardwood	251.0	0%	4.0%
Millwork	275.7	(0.1)	6.9
Mixed Fertilizers	262.3	(0.1)	9.6
Motor Vehicle Parts	311.6	0.3	28.7
Natural Gas	979.5	1.3[2]	26.0
Nonferrous Wire and Cable	208.8	(0.4)	(12.0)
Paint Materials	288.3	0	8.3
Paper	274.0	(0.1)	9.4
Paperboard	255.9	0.5	13.3
Pesticides	381.9	(0.1)[2]	1.8
Photographic Supplies	272.5	0.2	(7.8)
Plastic Constr. Prod. (12/69 = 100)	154.9	0.4	3.3
Plastic Film (12/70 = 100)	194.7	(0.3)	4.7
Plumbing Fixtures & Brass Fittings	259.2	(0.1)	6.9
Plywood	246.7	1.1	2.8
Portland Cement	321.2	1.4	5.9
Prepared Paint	246.9	0[2]	10.6
Refractories	297.1	1.3	16.6
Residual Fuel	1305.1	7.2	33.9
Sand, Gravel & Crushed Stone	260.3	0.7	13.3
Sanitary Papers & Health Prod.	347.9	0.2	10.7
Soaps & Synthetic Detergents	235.4	3.1[2]	11.8
Sporting Goods	210.4	0.5	8.3
Structural Clay Products	245.2	2.0[2]	5.9
Tires and Tubes	248.2	1.7	7.4
Tractor Parts	200.3	1.1[2]	13.0
Transformers & Power Regulators	202.6	4.5[2]	15.8
Valves & Fittings	304.2	1.1	9.4
Wiring Devices	292.5	1.0	12.7

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted

JULY 1981

American City & County

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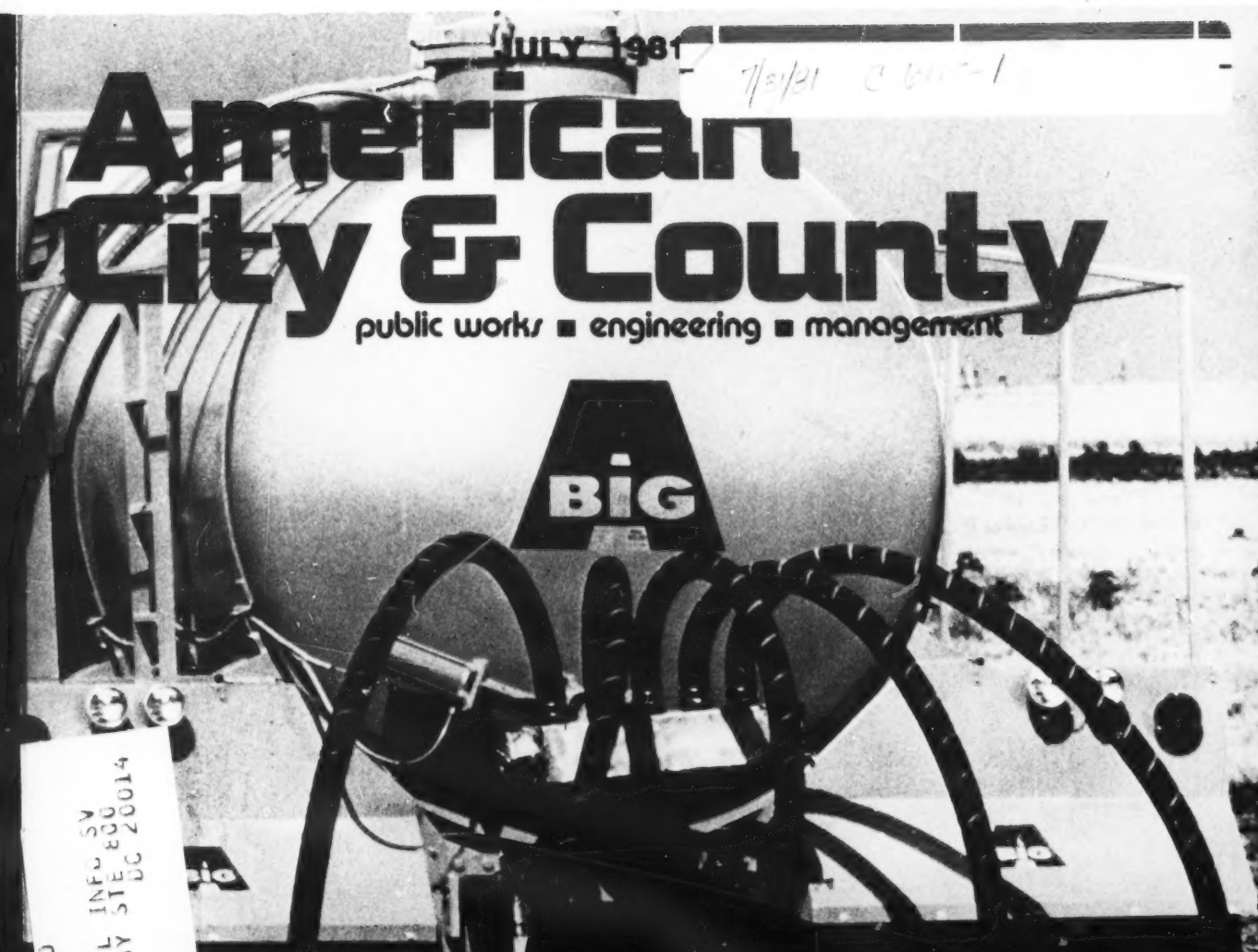

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SLUDGE DISPOSAL:

What it takes to be a 'good neighbor' site

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Energy costs jump 28.2 percent in 12 months.

On the cover: One of Rickel Manufacturing Corporation's *Big A* sludge applicator units prepares to inject digested sewage sludge into the earth of a farmer's field. In this month's cover story, **Michael Gerardi,** wastewater manager of the Williamsport (Pennsylvania) Sanitary District, discusses the problems and the benefits of this type of sludge disposal operation. And, just in case you want to try it too, we've also included product line profiles for over a dozen manufacturers of sludge applicator equipment.

LAND APPLICATION

Is sludge really beneficial?

A treatment plant manager says yes and tells what to watch out for in a sludge-to-crop land program to avoid potential crop and soil contamination.

By Michael H. Gerardi
Wastewater Manager
Williamsport (PA) Sanitary Authority

With sludge incineration costs increasing and ocean dumping due to end after this year, large-scale application of sewage sludge on land is growing in popularity. An estimated 31 percent, or 1.3 million dry tons annually, of all municipal sludge processed in U.S. wastewater treatment plants is now being applied to land for productive use. By 1990, about 5.6–7.6 million dry tons of sludge is expected to be spread, injected or knifed into American soils each year.

"Sewage farming" has been pursued in the United States since the 1890s. Then as now, land application not only solved the problem of ever accumulating sludge, but it also improved cropland by providing an inexpensive and excellent soil additive. Its application recycles plant nutrients; introduces essential micronutrients and trace elements to the soil; enhances crop yield; increases tillability, water-holding capacity and infiltration; and reduces runoff and erosion. The U.S. Department of Agriculture estimates that almost all of the sludge any given city generates could be used to produce high-quality top soil on lands disturbed by housing development. And the Environmental Protection Agency believes municipalities could save $100 to $500 million in sewage treatment costs annually by increasing land application 50 percent by 1990.

These agricultural programs are a windfall for farmers when the cost of commercial fertilizers, already high and continually rising, are taken into account. Sludge is considered a soil additive or supplement, rather than a fertilizer *per se*, because its nitrogen, phosphate, and potash concentrations are generally lower than what commercial fertilizers contain, and these concentrations vary from season to season. However, using sludge as a soil additive can produce fertilizer savings of $20 to $40 per acre and, when properly managed, can improve crop yield.

One ton of a typical municipal sludge contains from 40 to 120 pounds (from two to six percent) of available nitrogen, from 40 to 120 pounds of phosphate, and from two to 80 pounds (from 0.1 to 4.0 percent) of potassium. This sludge also contains from 500 to 1600 pounds (25 to 80 percent) of organic matter and various concentrations of other essential plant nutrients such as boron, calcium, iron, magnesium, manganese, and molybdenun.

Despite its beneficial properties, however, sludge can present human, animal, soil and crop risks which must be considered before any of the material is applied to farm nelds. After digestion, sludge may still contain heavy metals, pesticides, polychlorinated biphenyls (PCBs), and pathogens which may contaminate soil and crops — *if* proper precautions are not exercised before sludge is applied, and *if* these components are allowed to build to significant concentrations in the soil.

Metals controlling factor

Sludge containing heavy metals can be used safely if applied under carefully controlled conditions:

- It must be applied at a rate not exceeding 10 dry tons per acre per year for no more than three years; and
- The metals concentrations must be less than or equal to 2000 ppm of zinc; 1000 ppm of copper, chromium and lead; 200 ppm of nickel and 50 ppm of cadmium.

Significant quantities of cadmium, chromium, copper, lead, nickel or zinc in sludge could easily render soil useless for crop production by bonding chemically to the soil complex and becoming toxic to plants when excessive concentrations are established in the soil. Copper, for example, suppresses the development of fibrous roots and reduces crop yield, while zinc interferes with plant enzyme activity and alters plant growth and appearance.

However, good farming practices can prevent soil and plant damage. For example, the risk associated with cadmium, a nonessential plant element, can be reduced by maintaining a soil pH greater than 6.5, growing plants such as non-leafy vegetables that tend to exclude the metal from the whole plant or reproductive tissue, or growing nonedible crops. And nickel, a toxic element to plants in acid soil, should present no risk if soil pH is maintained at 7.0 or greater. Other metals sometimes found in sludge — aluminum, antimony, arsenic, mercury, and selenium — pose relatively little risk to plants and soil either because they are not highly soluble in neutral and well-aerated soils, are present in very small concentrations, are not taken up by plants or are excluded from plant aerial tissue.

Nitrogen concentration must be monitored carefully to assure that the element does not leach below the root zone. There, it changes to the nitrate form and may contaminate groundwater supplies.

Pesticides do not appear to hinder sludge land application as long as concentrations are small. However, PCB concentrations greater than 10 ppm are

The value of sludge*

Nutrient	Nutrient level: Low — Percent of dry sludge	Low — Value ($/ton)	Average — Percent of dry sludge	Average — Value ($/ton)	High — Percent of dry sludge	High — Value ($/ton)
Nitrogen	2.0	3.40	4.0	6.80	6.0	10.20
Phosphate	2.0	8.00	4.0	16.00	6.0	24.00
Potash	0.1	0.22	2.0	4.40	4.0	8.80
Total value		11.62				

*Based on 1980 prices of $0.17 per pound of nitrogen (assuming 50 percent of available nitrogen is used), $0.20 per pound of phosphate, and $0.11 per pound of potash.

considered unsafe. PCBs are banned by the federal government, but they may still be found in sludges of cities with capacitor or transformer manufacturers. Sewage authorities and independent laboratories can readily assess pesticide and PCB concentrations.

The risks associated with sludge pathogens — viruses, bacteria, fungi, protozoa, nematodes (roundworms), and tapeworms — are not so easily determined, however. These agents in sludge have never been directly incriminated in the transmission of a specific disease, but, since microbial pathogens cannot be completely removed by existing treatment methods, fecal contamination of crops and soil through sludge land application is an obvious hazard. This objection has been the source of many public protests against the practice of land application.

Pathogen considerations

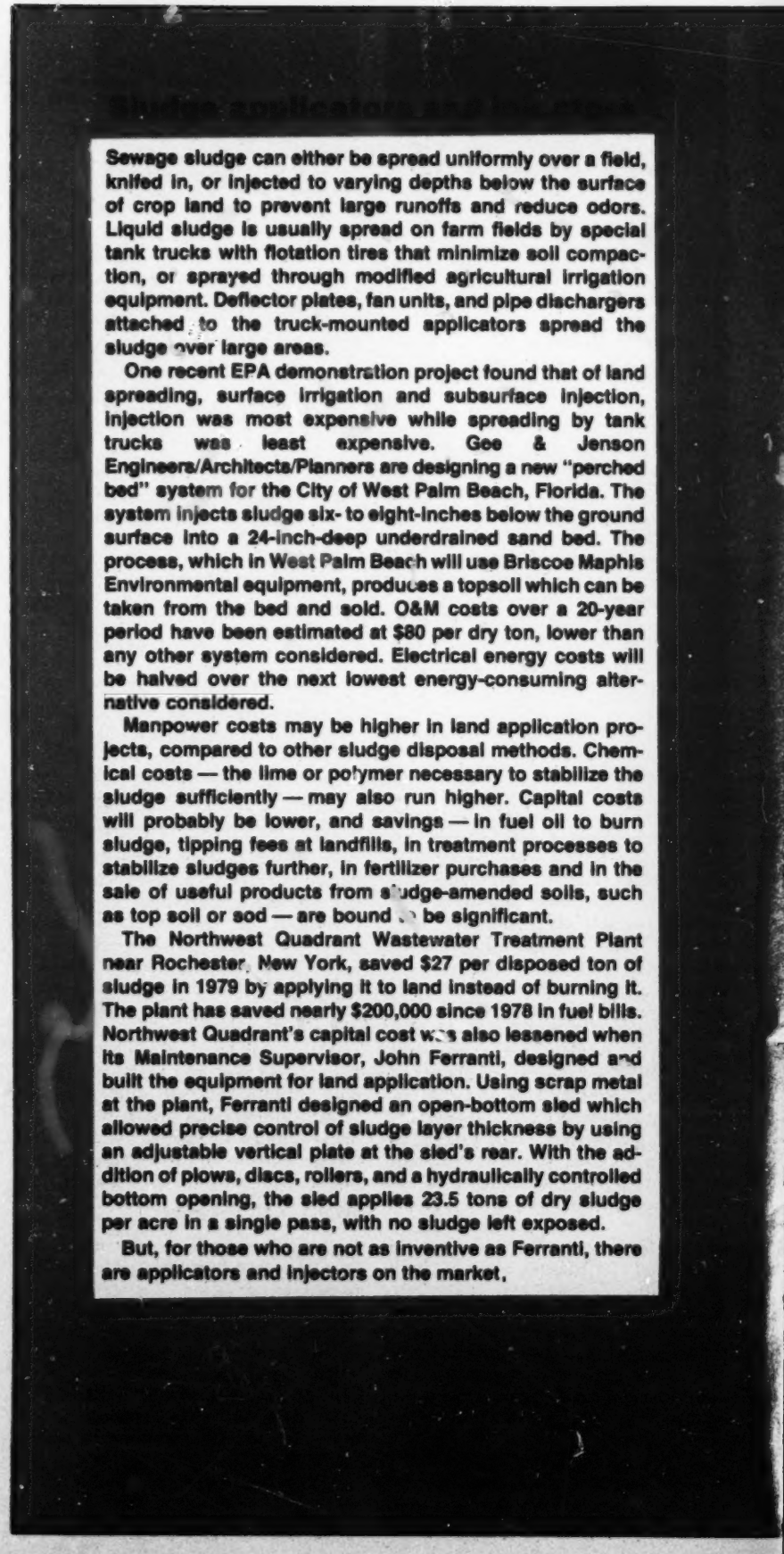
Research shows that *most* sludge pathogens are destroyed by digestion, and *many* surviving pathogens tend to die off in the soil environment. But *some* pathogens survive and may remain active in the soil for months, even years. They may establish themselves in macroinvertebrae such as earthworms or snails. There, they accumulate, survive and are again eliminated to the soil.

Of the pathogens, bacteria are most suspectible to destruction through sludge land application. Their numbers are greatly reduced by sunlight, drying, or competition with native soil bacteria, and they typically survive only a week or so. But viruses, such as *Hepatitis A*, may persist in soils and vegetables for weeks or months.

Of all pathogens, protozoa and nematodes are of greatest concern because they can produce cysts and large numbers of eggs which help them survive harsh environments. Many protozoan cysts are limited geographically or lack specific intermediate hosts. But four of them — *Balantidiasis, Amediasis, Giardiasis* and *Toxoplasmosis* — should be watched for. And intestinal roundworms are of even greater concern than protozoan parasites because these nematodes don't need an intermediate host. *Ascariasis, Enterobiasis* (Pinworm), Hookworms, *Strongyloidiasis* (Threadworm), and *Trichuriasis* (Whipworm) can all be transmitted through sludge-amended soils. Dog and cat roundworms and tapeworms (cestodes) are also potential hazards.

To avert this hazard in a land application program, federal, state, and local agencies have developed a set of precautions which should allow the safe and productive use of sludge on crop land:

- Sludge should not be spread near



Sewage sludge can either be spread uniformly over a field, knifed in, or injected to varying depths below the surface of crop land to prevent large runoffs and reduce odors. Liquid sludge is usually spread on farm fields by special tank trucks with flotation tires that minimize soil compaction, or sprayed through modified agricultural irrigation equipment. Deflector plates, fan units, and pipe dischargers attached to the truck-mounted applicators spread the sludge over large areas.

One recent EPA demonstration project found that of land spreading, surface irrigation and subsurface injection, injection was most expensive while spreading by tank trucks was least expensive. Gee & Jenson Engineers/Architects/Planners are designing a new "perched bed" system for the City of West Palm Beach, Florida. The system injects sludge six- to eight-inches below the ground surface into a 24-inch-deep underdrained sand bed. The process, which in West Palm Beach will use Briscoe Maphis Environmental equipment, produces a topsoil which can be taken from the bed and sold. O&M costs over a 20-year period have been estimated at $80 per dry ton, lower than any other system considered. Electrical energy costs will be halved over the next lowest energy-consuming alternative considered.

Manpower costs may be higher in land application projects, compared to other sludge disposal methods. Chemical costs — the lime or polymer necessary to stabilize the sludge sufficiently — may also run higher. Capital costs will probably be lower, and savings — in fuel oil to burn sludge, tipping fees at landfills, in treatment processes to stabilize sludges further, in fertilizer purchases and in the sale of useful products from sludge-amended soils, such as top soil or sod — are bound to be significant.

The Northwest Quadrant Wastewater Treatment Plant near Rochester, New York, saved $27 per disposed ton of sludge in 1979 by applying it to land instead of burning it. The plant has saved nearly $200,000 since 1978 in fuel bills. Northwest Quadrant's capital cost was also lessened when its Maintenance Supervisor, John Ferranti, designed and built the equipment for land application. Using scrap metal at the plant, Ferranti designed an open-bottom sled which allowed precise control of sludge layer thickness by using an adjustable vertical plate at the sled's rear. With the addition of plows, discs, rollers, and a hydraulically controlled bottom opening, the sled applies 23.5 tons of dry sludge per acre in a single pass, with no sludge left exposed.

But, for those who are not as inventive as Ferranti, there are applicators and injectors on the market.

Ag-Gator* and *Terra-Gator are, respectively, land application and sub-surface injection machines manufactured by Ag-Chem. *Ag-Gators 1004, 2004 and 3004* (a 3200-gallon unit) are four-wheel-drive with three-point articulation that allows a 40-degree steering angle and small 22-foot turning radius. Pressure-vacuum pumping system never comes in contact with sludge and can move 192 cubic feet of material a minute. Low porthole windows in cab allow operator view of front tires. *Ag-Gators* can spread sludge in swaths from 12 to 35 feet. Ten-speed manual transmission is standard, and injector system comes as option.

Five-wheel *Terra-Gator 2505* has 4000-gallon tank and tandem suspension to reduce bump shock as wheels roll independently. Unit can induct, transport and apply up to 150,000 gallons of sludge a day and has optional 17-ton caked waste application system. Flotation tires exert only 15 psi pressure on ground. Five-shank injector system has optional "floating" tool bar that will maintain consistent injection depth despite changes in terrain. Other options include rolling coulters for vegetative cutting, multiple deflectors for surface spreading and solid waste dry boxes for spreading in 12- and 30-foot swaths. *Ag-Chem Equipment Company, Inc., 4900 Viking Drive, Minneapolis, Minnesota 55435.*

Big Wheels' newest unit in its line of high flotation field equipment is a dual purpose, liquid fertilizer/liquid waste applicator with 1600-gallon stainless steel tank and three-knife sub-surface injection system. Shock and tilt boom assembly handles all types of fertilizer. Centrifugal pump can handle 90,000 gallons of sludge a day, at cost of $0.01 per gallon, and buries to depth of nine inches. Ground-speed-sensitive metering system provides accurate flow rates. Vacuum/pressure liquid sludge applicator unit with 1500-gallon tank can inject 100,000 gallons of sludge in eight hours or less, and company's dry sludge applicator has 7.2 cubic yard bed and applies sludge by drag chain conveyor. Cab-operated feed gate 30 inches wide controls application rate. *Big Wheels, Inc., PO Box 113, Interstate 57 & Route 9, Paxton, Illinois 60957.*

Briscoe Maphis makes land application and sub-surface injection equipment and provides contract services, demonstration projects, engineering and R&D for cities with sludge disposal and/or use problems. Sub-surface injection system is made of welded steel and operates from small crawler-type tractor. Mobile units connect to sludge source through reinforced rubber hoses that allow coverage of 15–18 acres from each attachment point. Units can work at rates up to 1200 gpm and injects to depths of six to ten inches under low pressure. Injector shanks do injection, mixing and covering in one operation. Accompanying leachate collection system can be installed to sample sludge movement toward aquifers. *Briscoe Maphis Environmental, 5378 Sterling Drive, Boulder, Colorado 80301.*

Converto's *Ram-E-Jec* system allows transport and disposal of semi-trailer loads of sludge. Hydraulic ram-blade controlled by operator wipes trailer bed clean, and special horizontal discharge system solves uneven feed problems. Unit can spread, windrow or stockpile sludge and unload in pile or row. System can be mounted on truck or trailer. *Converto Manufacturing (Division Cego Inc.), Cambridge City, Indiana 47327.*

Environetics' *Controliner* is a sattelite waste storage tank that can hold from 30,000 to 550,000 gallons of sludge at an application site. Buried tank is prefabricated thermoplastic membrane liner with sealed, floating cover. Anaerobic digestion occurs in pit while material awaits application or injection. *Controliner* takes a day or less to install after excavation and is useful at sites where cold weather or soil conditions inhibit application. Eliminates odors and can store materials of 15 to 25 percent solids. *Environetics, Inc., 9824 Industrial Drive, Bridgeview, Illinois 60455.*

Field Gymmy, Inc., manufactures surface and sub-surface sludge application equipment, as well as semi-tankers for liquid transport and live-bottom semi-trailers for cake and dried sludge transport. Automatic transmission models come in two- and four-wheel-drive, gas or diesel. Units, with 66-inch flotation tires, can run over road at 50 mph and in the field at three mph. The 2000-gallon tank has load level indicator, alarm and automatic shut-off. Full-length catwalks allow easy inspection of system. Unit has automatic positive depth control, oversize feeder tubes from tank to reduce clogging, and cab-mounted plow control. *Field Gymmy, Inc., PO Box 26, Glandorf, Ohio 45848.*

I.M.E., Inc., features a complete line of trailer- and chassis-mounted sludge application equipment, including custom designs and off-road vehicles from 800- to 3300-gallon capacities. Sludge injection system opens any tillable soil up to a foot deep and injects sludge, lime slurries, industrial wastes and other slurries at a rate of 600 to 800 gpm. *I.M.E., Inc., PO Box N, Galva, Illinois 61434.*

Knight's sludge spreaders are available in 13-, 10-, eight- and six-cubic yard capacities and have been on the market some 30 years. The most popular model, the *500*, is a 10-cubic-yard unit with three auger beaters, two to spread the main load of sludge and a lower spinner-beater to catch and spread "dribblings." The beaters have alloy steel "ripper teeth" for even spreading. Mounted at the factory on municipal trucks, the spreaders come with clearance lights, fenders, mud flaps, cab guard, truck drive line, hydraulic end gate (right-sealing to assure safe travel over the road), and 12-volt hydraulic pump. *Knight Manufacturing Corporation, 1401 West Eighth Avenue, Brodhead, Wisconsin 53520.*

Lely's *Stallion* sludge system has power-take-off-drive vacuum-pressure pumps that reduce chance of freeze-ups. Operator can switch from vacuum to pressure application readily. Liquid waste can be surface applied or injected to depth of 10 inches. Tanks range from 2000 gallons on up. *Lely Manufacturing, Box 1060, US 301 South, Wilson, North Carolina 27893.*

Lindsay's *Zimmatic* electric-drive center pivots, usually used to apply effluents, have solids handling option to apply sludge. This option uses volume guns with 0.6-inch minimum nozzles to accomodate sludge solids. Electric valves assure uniform distribution. Mobile pivot can apply wastes on from five to 40 acres in each setting and then wheels easily to next location. Wheel-mounted, motor-driven towers rotate about fixed point to transport position. Main panel controls pivot opreation, analyzes incoming and system voltage and individual tower performance. *Lindsay Manufacturing Company, Lindsay, Nebraska 68644.*

Rickel Manufacturing's *Big-A* lines includes the *3500* for dewatered wastes (with a 2200-gallon tank) and the *4500* for liquid sludges (with a 3500-gallon tank). In *3500*, hydraulically driven beaters with hard-surfaced combs shred and spread sludge, fed from a rivetless heat-treated chain. Apron speed varies from 0 to 12.7 fpm, and spreading capacity ranges from one to 25 cubic yards per acre. For surface application, units can be equipped with single flood jet or manifold bar. For sub-surface injection, *3500* comes with three- or four-shank tool bar; the *4500*, with five-shank assembly.

Shanks are either heavy-duty tillage type or grassland type for pasture or hay land where soil structure and root systems must be preserved. Tillage shanks inject to 17 inches, have spring trip, automatic re-set, and 30-degree lateral movement around field obstructions so sludge is not spilled on surface. *Big-A* units are either four- or five-speed automatic transmission. Company also makes a 6600-gallon *Nurse Tank* for sludge transport, *A2600* spreader, and has three types of lease-purchase plans for municipalities. *Rickel Manufacturing Corporation, Airport Industrial Center, PO Box 897, Salina, Kansas 67401.*

Star-Line Fabricators, Inc., manufactures the Meincke *Liqui-Spread* slurry applicator with a 1000-gallon round fiberglass tank equipped with cab-controlled three-inch butterfly valve for gravity discharge. Truck-mounted tank has cat-walks on both sides and stainless steel paddle agitation system. *Star Line Fabricators, Inc., PO Box 98, Astatula, Florida 32705.*

Valmont's center pivot slurry shooters can handle sludges of up to six percent solids through aluminum alloy large-volume Nelson end guns that handle 75 gpm each. Shooter systems are custom designed with anywhere from one to eight spans, each ranging from 126 to 185 feet long. Unit can be anywhere from 200 to 2000 feet long, can handle 250 to 2500 gpm, and cover 10 to 300 acres. End guns are automatically sequenced by electrically driven patented sequence controls on pivot. Each sprinkler has air-actuated hydraulic valves. Valmont Industries, Inc., Valley, Nebraska 68064.

Ward Commons' *Wolverine* "swamp buggy," invented in 1956, is a three-wheel high-flotation vehicle which minimizes ground compaction since no one wheel runs over the track of the others. The five *Wolverines* range from six- to 12-ton pay load capacities, or from 1000- to 2500-gallon sludge handling capacity. The system, which can load from tank-trailer or lagoon, applies sludge by deflector-type nozzle that spreads a 30-foot swath in one pass. Three-wheel design is claimed to provide greater traction as well.

Company says 95 percent of units are still producing in the field at favorably low cost per acre. Front-end cab can withstand up to 44,000 pounds direct pressure without crushing. Two-speed rear axle is fitted with disc brakes to end downhill "runaways." Three-wheel drive, gas or diesel engine, and transmissions from five-speed automatic to 13-speed manual are available as options. *Ward Commons Manufacturing Company, Inc., 38054 Jefferson-Scio Road, Scio, Oregon 97374.*

streams, water supplies, property lines, and occupied dwellings, or on land which floods, erodes or experiences soil movement;

- As the Food and Drug Administration recommends, food crops to be eaten raw should not be grown in sludge for at least three years after the last application of sludge;
- Sludge should be used only after it has been digested, heated, or stabilized in some fashion, and it should be applied at rates established by either nitrogen or metal concentrations;
- Soil which has been treated with sewage sludge should be monitored periodically by commercial laboratories or professional agricultural consultants to determine metal build-up; and
- Livestock should not be allowed to graze in pastures which have sludge residues on the vegetation.

Although these guidelines reflect the present views of various individuals and agencies on sludge land application, they have no official validity. Experience shows, however, that many local agencies which have followed these procedures have to date experienced little problem with sludge land application.

Fitchburg, Massachusetts, which applies a high-lime-stabilized, vacuum-filtered sludge to rye grass and corn, has seen no significant heavy metal uptake in plants and no significant nitrate buildup in nearby streams at application rates of 72 dry tons per acre. Enfield, Connecticut, has found sludge added to its sandy loam soil to be an excellent fertilizer, but a 0.1 rise in pH over a three-year period temporarily halted the program. However, the city saved 210,000 gallons of fuel oil by not burning its sludge.

According to EPA, the job of maximizing the use of sludge on land lies principally in the hands of municipalities. Whether the 1990 expectations about the amount of sludge being used beneficially on crop land are met, the agency says, "depends in great part on the extent to which municipalities adopt land treatment." And because of the role transportation costs from sludge generation points to application sites has on the overall cost of any program, EPA notes that municipalities will have to carry the ball to keep costs competitive. "If sewage sludge is to compete with commercial fertilizers," says the agency, "the costs for the operation will have to be borne by the municipality generating the sludge. If it were to transport the sludge to the application site and provide the application equipment, the sludge would be a sought-after commodity." **ACC**

For a free copy of this article, write 186 on Reader Service Card.

Cart collection trials show it pays

A refuse collection technology innovator explains the whys, wherefores and how-tos of putting semi-automated or automated cart collection systems in place.

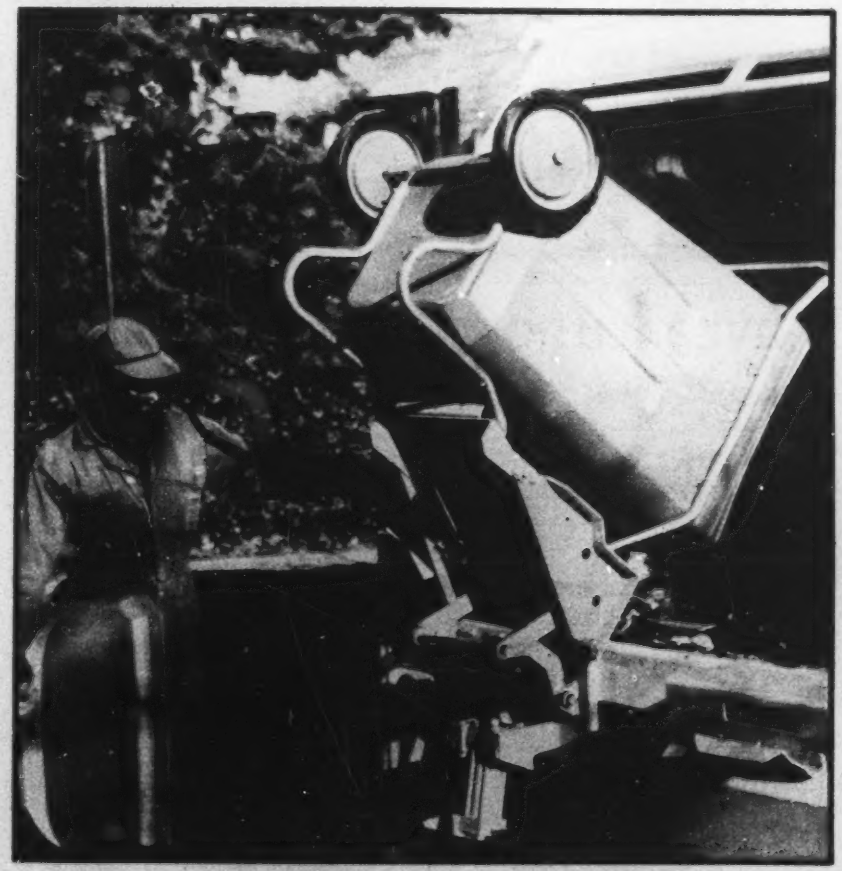
By Donald F. Norris
Municipal Technical Advisory Service
University of Tennessee
Knoxville, Tennessee

Despite skyrocketing costs, most cities in the United States collect residential refuse much as they did 30 or 40 years ago. Refuse collection vehicles are larger and more efficient, but sanitation workers by and large continue loading refuse manually. In many places, backyard and twice-weekly collections are still standard practice.

However, advances in technology and the development of new and improved concepts of refuse collection have not only made conventionally accepted collection methods obsolete but have also created cost-effective alternatives to these historically labor-intensive activities. Curbside collection, for instance, has been shown to be more cost-effective than backyard collection. And, once a decision has been made to convert to curbside collection, a community also has the opportunity to implement an automated or semi-automated collection system.

An automated or fully mechanized refuse collection system is one in which a single crew member, remaining in the cab of a specially designed side-loading vehicle, operates equipment which automatically empties standardized containers left at the curbside. In a semi-automated system, crew members wheel containers from curbside to the collection vehicle and attach them to mechanized dumping devices (called flippers) which lift and dump them. Crew members then disengage the containers and return them to the curbside. Semi-automated or partially mechanized systems can be adapted to either rear-loading or side-loading collection vehicles.

The critical ingredient in automated and semi-automated refuse collection systems is the curbside collection of standardized, wheel-type refuse containers or carts. The lifting and dumping devices on automated or semi-automated vehicles are engineered to handle only containers of a standard

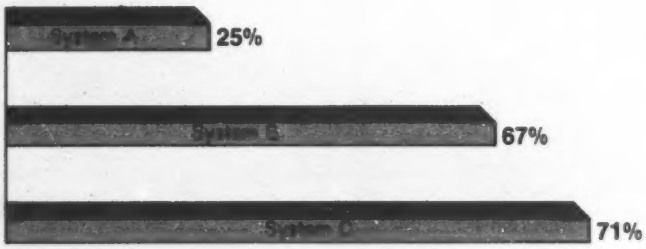


An automated system such as in Phoenix, Arizona, (above) relies on a single crew member to operate a lifting arm which picks up and empties the container or cart. **The semi-automated system** used in Atlanta (below) uses 'flippers' to gain productivity from rear loading compactors.

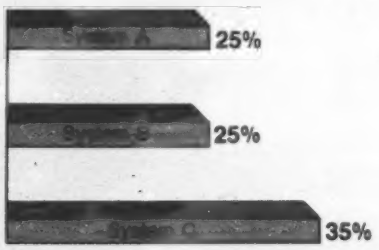
Savings achievable using cart collection systems*

EQUIPMENT
BASED ON SIX-YEAR LIFE CYCLE; $6000 PER YEAR FOR REAR LOADERS; $9750 PER YEAR FOR SIDE LOADERS.

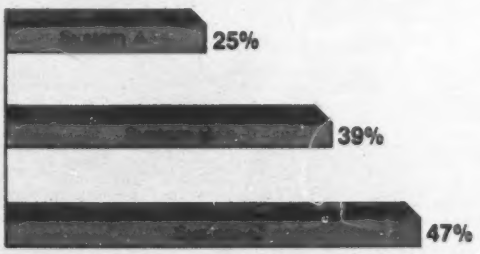
LABOR
BASED ON ESTIMATED $200 PER WEEK SALARY PER CREW MEMBER.



OTHER COSTS
INCLUDES FRINGE BENEFITS AT 25% AND SUPERVISION AT 6.5% OF SALARY; EQUIPMENT STORAGE AND INSURANCE AT 10% ANNUAL EQUIPMENT COSTS; AND VEHICLE O&M BASED ON ESTIMATED USAGE.



OVERALL POTENTIAL SAVINGS



*AS COMPARED TO BASE SYSTEM USING TWO MANUAL REAR LOADERS WITH THREE-PERSON CREWS, CURBSIDE COLLECTION, 500 CUSTOMERS PER DAY PER VEHICLE. **System A:** Two semi-automated rear loaders, curbside cart collection, three-person crews, 700 customers per day per vehicle. **System B:** Two semi-automated side loaders, curbside cart collection, one-person crews, 500 customers per day per vehicle. **System C:** Two automated side loaders, curbside cart collection, one-person crews, 600 customers per day per vehicle. **All systems** serve 4000 customers a week.

design. And, because the containers are fairly large compared with the average household refuse container — 80- or 90-gallon sizes are typical — built-in wheels and handles are necessary to enable residents to move them easily to the curb.

Experience with cart collection systems, whether using automated or semi-automated collection equipment, shows that they perform well. Cart systems are reliable, efficient, less labor intensive, reduce on-the-job injuries and can be adapted to operate effectively despite climate, terrain, or street configuration. A marked reduction in litter associated with refuse collection can also be expected. Standardized containers are constructed to resist being tipped over and, with their lids securely in place, spilling is virtually impossible. Also, dogs and other neighborhood animals in search of garbage do not find the carts an appealing target.

Early concerns about the effects of temperature extremes on the carts — most of them are made of polyethylene — have proved groundless. Manufacturers routinely warrant their units for five or more years, and depending upon bid specifications and quantity purchased, communities may be able to secure even longer warranty periods.

Communities typically implement cart collection systems to reduce costs and boost productivity. Our estimates show that of five different refuse collection technologies, each serving 4000 customers per week, an automated side-loading system can serve 600 customers per day per vehicle for an estimated cost of $0.96 per customer per month. By contrast, a manual, backyard collection system operated under similar conditions would cost about $2.68 per customer per month.

Both large and small cities can make substantial improvements in collection cost with cart systems. Maryville, Tennessee (population 17,000), implemented a fully automated cart collection system in 1979 and is saving more than $100,000 a year over the cost of its previous system. Memphis, a metropolitan city of 645,000 persons, began implementing a cart system using semi-automated equipment in 1980. When fully implemented this fall, the city expects annual savings of $9.2 million annually over the cost of its previous collection system. Projected savings in both cities include the cost of new equipment — new automated side-loading collection vehicles and carts in Maryville; carts and flippers for existing rear-loaders in Memphis.

Despite the fact that cart collection systems are clearly a cost-effective alternative to conventional refuse collection practices, their adoption has been gradual. Recent evidence suggests an

acceleration in the trend, very likely as the result of cost considerations, the increased availability and reliability of systems, and the increased knowledge of and experience.

Still, only 200 or fewer communities in the United States have converted to cart collection systems. If it is assumed that a city with a population of 5,000 is about the smallest that could financially justify complete conversion to a cart collection system, about five percent of the cities in the country which appear to be likely candidates for cart collection systems have actually implemented them. The percentage of *all* local governments using cart systems among those with sufficient population to justify such a system, however, would be even lower if urban townships and counties which could justify cart collection were added.

Typically, in converting from a conventional to a cart collection system, the local government buys the containers and gives them to residents, who are then responsible for their care. Carts which are damaged or broken as the result of collection or defects in material or workmanship are covered by the vendor's warranty and are replaced at no cost to the resident. Carts which are lost, stolen or vandalized are the responsibility of the resident, as they would be in a conventional collection system.

Container costs are usually included in overall system costs with complete equipment payback figured into total system life and financing. The City of Memphis, for example, purchased 180,000 containers in its conversion to semi-automated, curbside collection and expects full cost payback to occur within the first 10 months of operation.

Standard 80- or 90-gallon wheel-type residential refuse containers cost from $40 to $50 each and last from eight to 10 years.

When purchasing containers, local officials should make sure that the carts are compatible with the automated or semi-automated equipment used in the system. In particular, the fittings on the carts must be designed to work on the lifting device of the equipment the local government owns or intends to purchase. Compatibility problems between carts and lifting devices can result in considerable cost, inconvenience and delay in system implementation and can produce serious long-term operational headaches.

Prior to the equipment's arrival, the sanitation department must address three operational issues if optimal performance of the cart collection system is to result — route design, operator training and equipment maintenance.

Refuse collection routes must be completely redesigned to accommodate the carts, as well as to achieve the maximum feasible productivity for the system. Topography, street width, type of system (i.e., semi-automated or automated), crew size, productivity standards, truck capacity, and frequency of collection all need to be considered.

Cart systems are generally implemented in conjunction with purchases of automated side-loading or semi-automated side-or rear-loading collection vehicles. Since the collection vehicles and their lifting devices are mechanical beasts, they can be expected to fail from time to time. As the effective operation of the mechanized equipment is critical to overall system effectiveness, back-up equipment and a sound maintenance program are essential.

A maintenance program should include personnel trained specifically to repair and maintain the collection vehicles and lifting devices both in the shop and on the street, to perform minor adjustments on the carts, and to plan and carry out a regular preventative maintenance program. Do not skimp on the training needs of maintenance personnel, nor fail to provide them with equipment necessary to do the job. As the fellow on the TV commercial says, "You can pay me now, or pay me later." Good preventative maintenance and well-trained maintenance personnel will save time, money and considerable agony for a community implementing a cart system.

Employees, whether unionized or not, are likely to fear that implementation of a cart system will result in lay-offs, especially since the reduction of labor cost through personnel reduction is a key reason for installing cart systems. These concerns of labor are often justified. Although Phoenix, Arizona, was reported to have reassigned all sanitation workers replaced by its automated system, not all cities can expect to be as fortunate. In Memphis, for example, several hundred CETA employees will be laid off as a direct result of the cart system. However, no regular employees in Memphis will lose their jobs. The city is using attrition and transfers to reduce the number of regular sanitation department employees.

Regardless of a city's ability to avoid lay-offs and terminations, it should deal with employees and unions straightforwardly and honestly. Employee and union cooperation should be sought in system design and implementation. After all, the employees are ultimately the persons who will make the system work — or not work. And employees pay taxes. They are likely to be interested in cost reductions in local government as long as these reductions are undertaken fairly and humanely.

The same is true in the establishment of productivity standards. Although employees and employee unions may voice concern and even opposition to establishing productivity standards, it is clearly management's right to do so. Nevertheless, management must exhibit wit and sensitivity when establishing them, if for no other reason than to ensure their equity. **ACC**

For a free copy of this article, write 180 on Reader Service Card. The Municipal Technical Advisory Service has produced an 18-minute color film, "There is a Better Way," on a study in Memphis testing various containers and refuse collection equipment. The film may be purchased from MTAS for $125 ($40 for videotape) or rented for $10 a week. Write to "Refuse Collection Film," MTAS, University of Tennessee, 891 20th Street, Knoxville, TN 37916.

Standardized Wheel-Type Refuse Container Sources

★ **American Refuse Systems**
Box 1030
Roanoke Rapids, NC 27870
(919)537-1665

★ **EMCO**
★ P.O. Box 1925
Plainview, TX 79072
(806)293-5285

★ **Rubbermaid Applied Products**
★ P.O. Box 5338
★ Statesville, NC 28677
(704)872-8171

★ **Heil Rotomold, Inc.**
108 Pioneer
Phoenix, AZ 85040
(602)268-8688

★ **Zarn, Inc.**
★ P.O. Box 1350
Reidsville, NC 27320
(919)349-3324

★ **P.P.I. Industries, Inc.**
★ 433 Industrial Road
Goddard, KS 67052
(316)794-2213

★ **Reuter, Inc.**
410 11th Avenue South
Hopkins, MN 55343
(612)935-6921

★ **Turn-Key Container Systems**
9775 Eton Avenue
Chatsworth, CA 91311
(213)709-6789

Cylindrical containers ★
Rectangular-topped containers ★★

Municipal Cost Indexes

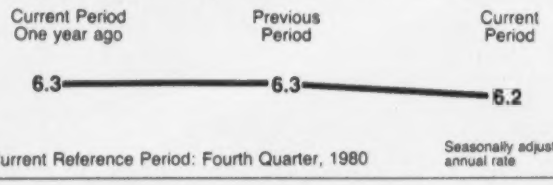
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 288.3 +1.3% +10.6%

Consumer Price Index	266.8	0.6%	10.0%
ACC Construction Cost Index	313.3	2.3	9.2
General Construction Materials	300.8	1.8	10.8
Motorized Equipment	267.0	1.0	12.5
Energy; Fuels and Power	855.6	1.5	28.2
Consumable Supplies	283.7	1.0	13.9
Producer Price Index	267.7	0.9	10.6

MUNICIPAL TREND TO WATCH

Purchases of Durable Goods, Billions of Dollars



Current Reference Period: Fourth Quarter, 1980

Seasonally adjusted annual rate

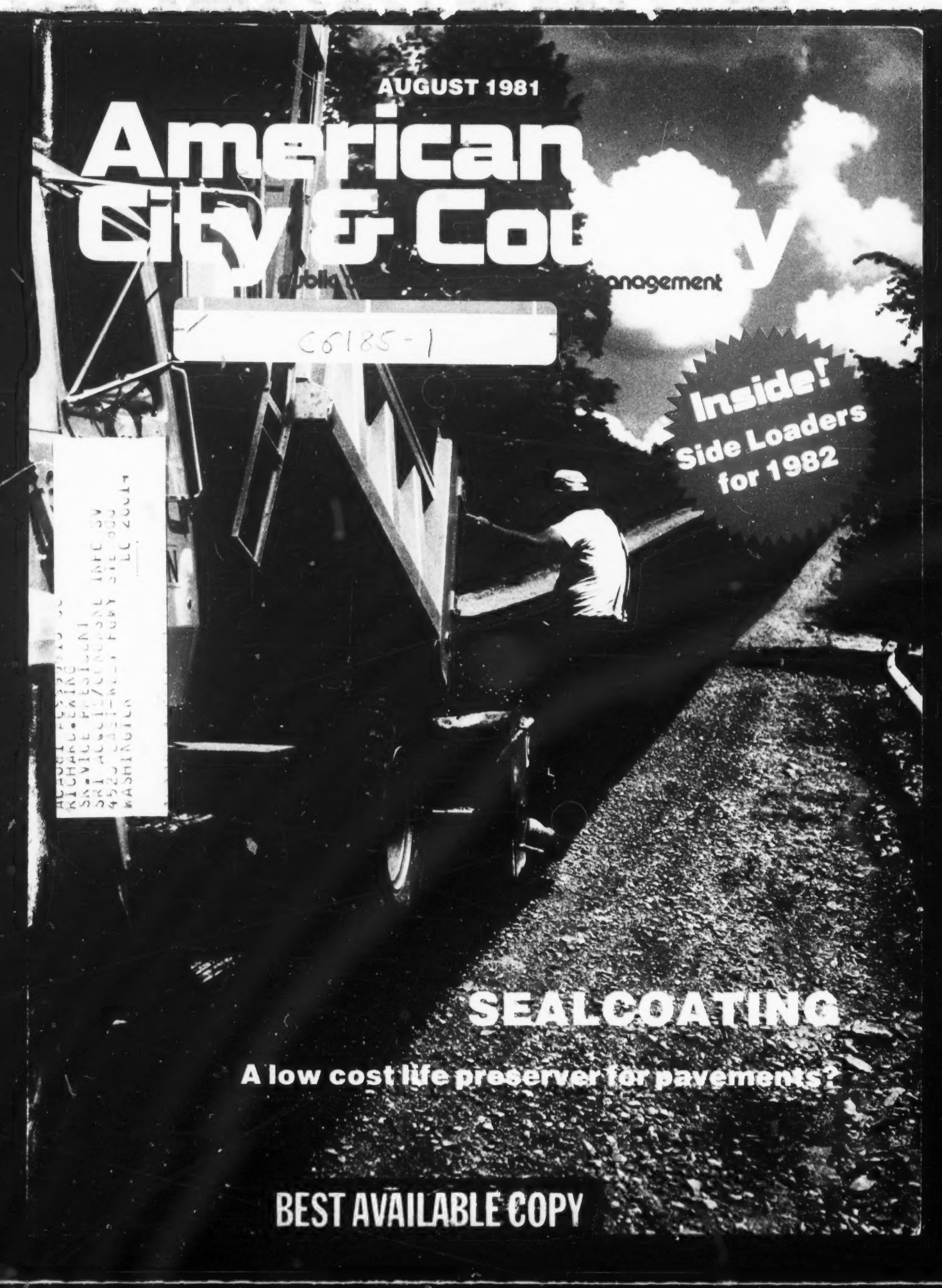
CAPITAL EQUIPMENT 260.5 +1.0% +10.3%

Agricultural Machinery & Equip.	281.2	0.9%	10.5%
Air Conditioners (12/77 = 100)	126.6	0.2	5.0
Construction Machinery & Equip.	314.7	1.1	10.7
Electric Motors	269.7	1.4	8.6
Environmental Controls (6/80-100)	101.9	(1.5)	—
Fans and Blowers (Ex. Portable)	314.2	0.7	7.2
Fluid Power Equipment	216.4	0.7[2]	10.0
Generators and Generator Sets	324.3	1.2[2]	17.3
Heating Equipment	218.8	0.6[2]	7.1
Industrial Material Handling Equip.	270.9	0.6[2]	8.5
Integrating & Measuring Inst.	193.9	0.7	6.7
Internal Combustion Engines	295.3	1.8%	12.2%
Motor Trucks, Light	246.5	2.8	14.9
Motor Trucks, Heavy	270.2	0.5	10.6
Office Machines	146.9	0.5[2]	4.0
Passenger Cars	202.0	1.8	7.3
Photographic Equipment	130.0	0.6	5.3
Pumps, Compressors & Equipment	315.9	0.2	11.4
Railroad Equipment	341.8	1.8[2]	10.3
Refrig. Compressors (12/77 = 100)	127.9	0.1[2]	4.5
Switchgear, Switchboard Equip.	245.7	1.1	4.6

INDUSTRIAL COMMODITIES 309.0 +1.4% +10.7%

Abrasive Products	272.8	0.6%	8.6%
Apparel	182.1	1.1	7.1
Asphalt Roofing	416.3	3.9	1.8
Building Paper and Board	231.9	2.0	15.2
Coal	486.4	1.1	4.6
Commercial Furniture	254.3	0.4[2]	8.9
Concrete Products	289.5	0.9	6.1
Diesel Fuel (2/72 = 100)	870.2	2.5[2]	26.1
Drugs and Pharmaceuticals	223.2	0.5[2]	11.3
Electric Lamps/Bulbs	268.9	1.1[2]	9.5
Electric Power	355.8	1.5	14.7
Electronic Components	166.2	(0.1)	8.3
Fabricated Structural Metal	293.5	1.4	9.1
Finished Lubricants	340.5	1.6[2]	11.6
Finished Steel Products	330.6	1.0	9.1
Flat Glass	208.1	1.6[2]	6.6
Floor Coverings	176.2	1.3	8.6
Footwear	241.1	0.2	4.0
Footwear, Rubber	219.2	0	5.8
Foundry Products	323.5	0.5	5.8
Fuel Oil, No. 2 (2/73 = 100)	903.9	2.0	30.4
Gasoline	752.0	2.0	18.7
Glass Containers	326.0	4.7	10.8
Gypsum Products	256.8	(0.3)	(2.7)
Hand Tools, Power (12/76=100)	139.0	0.1[2]	13.1
Hardware	256.4	0[2]	8.0
Industrial Chemicals	360.8	2.4[2]	12.0
Kerosene (2/73 = 100)	867.6	1.9	29.4
Lumber, Softwood	352.5	2.5	9.0
Lumber, Hardwood	251.4	0.2%	(1.2)%
Millwork	276.5	0.3	7.4
Mixed Fertilizers	263.2	0.3	7.9
Motor Vehicle Parts	313.5	0.6	28.4
Natural Gas	999.4	2.0[2]	25.1
Nonferrous Wire and Cable	209.3	0.2	(7.2)
Paint Materials	295.2	2.4	8.5
Paper	275.5	1.0	2.9
Paperboard	257.8	0.5	8.7
Pesticides	381.9	0[2]	1.5
Photographic Supplies	272.5	0	(2.9)
Plastic Constr. Prod. (12/69 = 100)	155.0	0.1	1.9
Plastic Film (12/70 = 100)	207.4	6.5	11.1
Plumbing Fixtures & Brass Fittings	265.2	2.3	8.8
Plywood	254.4	3.1	15.7
Portland Cement	328.9	2.4	5.2
Prepared Paint	248.5	0.6[2]	7.3
Refractories	297.3	0.1	13.6
Residual Fuel	1315.2	0.8	40.9
Sand, Gravel & Crushed Stone	262.4	0.8	12.9
Sanitary Papers & Health Prod.	347.9	0	9.0
Soaps & Synthetic Detergents	238.5	1.3[2]	11.7
Sporting Goods	211.7	0.6	8.3
Structural Clay Products	245.6	0.2[2]	4.5
Tires and Tubes	250.3	0.8	8.0
Tractor Parts	209.3	4.5[2]	16.9
Transformers & Power Regulators	204.4	0.9[2]	15.0
Valves & Fittings	293.3	0	13.8
Wiring Devices	294.8	0.8	13.0

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted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Government truck purchases up 12.5% over last year

On the cover: The highway department crew of Granville, New York, assisted by personnel and equipment from neighboring towns, takes advantage of summer weather to upgrade a previously unpaved road with an asphaltic surface treatment. Under the direction of Superintendent of Highways John Cosey, they follow up a tack coat of MC-30 applied at a rate of 0.5 gallons per square yard with 30 pounds per square yard of No. 1 stone. The following day, the treatment was duplicated, this time using CRS-2 as the binder. Photo by John O'Connor.

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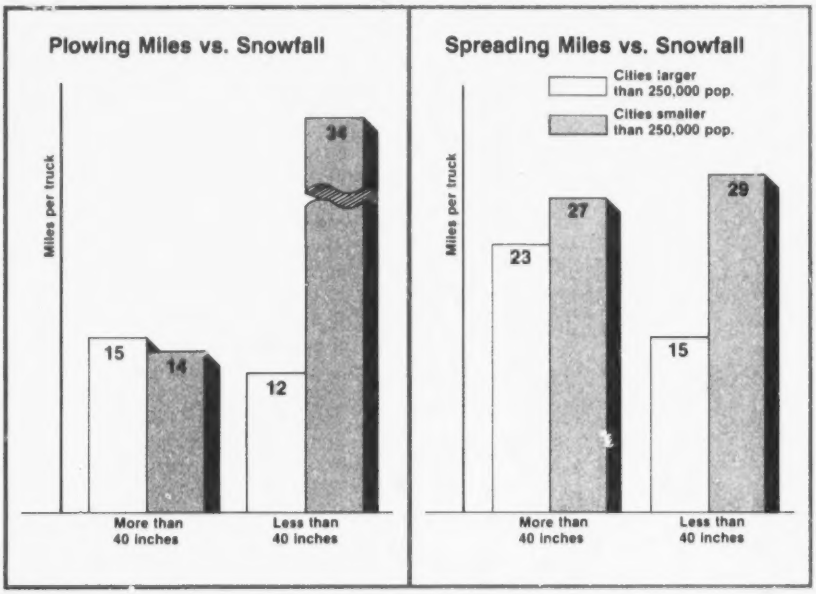
Cities vs. snow: How goes the battle?

Forty-six U.S. and Canadian snowbelt cities provide new data and insights on the resources that are committed to snowfighting.



When Mother Nature decides that it's time to blanket a city in white, most snowfighters can count on spending 12-hour days, pushing the snow from roadways and spreading abrasives and/or salt. That was one of the findings of a survey made by James Jester, superintendent of the highway maintenance department for Cincinnati, Ohio. Jester reported his findings at the 1981 North American Snow Conference.

Survey forms were mailed to 65 U.S. and 13 Canadian cities. Of these, 38 U.S. cities — 58 percent — responded, as did eight Canadian cities, 62 percent of those contacted. The cities were categorized as large — those with populations of 250,000 or more — and small or medium, those housing fewer than 250,000. Cities also were categorized by snowfall. Heavy snowfall was defined as 40 inches or more per year, while light to medium snowfall was any lesser quantity.

The use of these population and snowfall ranges enabled Jester to group the responses into four convenient categories:

- Large cities with heavy snowfall
- Large cities with light to medium snowfall
- Small to medium cities with heavy snowfall
- Small to medium cities with light to medium snowfall

Snowfall and snow control

The average annual snowfall for all cities surveyed was 40 inches. The large cities with heavy snowfall averaged eight snowstorms per year, which dropped a total of 56 inches of snow. The small to medium cities with heavy snowfall averaged more storms per year — 14 — but slightly less annual snowfall: 53 inches. Large cities with heavy snowfall spent an average of $3,282,000 per year on snow removal; smaller cities in the same snow category spent an average of $462,500.

Larger cities that received less than 40 inches of snow per year experienced more frequent snowstorms than large cities with heavy snowfalls, while the opposite was true for the smaller cities. Large cities with light snowload averaged 22 inches of snow per year from 14 storms; smaller cities averaged 24 inches from eight storms. Large cities with light snow averaged an annual snow removal expenditure of $1,270,000, while that of their smaller counterparts was $140,000.

The reporting cities, depending upon their size and the annual snowfall, varied widely in the percentage of their streets that they covered in snow and ice control activities:

- All cities — 71% of their streets are either plowed or salted or both
- Heavy snowfall — large cities, 72%; small cities, 94%
- Light snowfall — large cities, 55%; small cities, 64%

Large cities had distinctly different preferences in spreading equipment than those of their smaller counterparts. Of the 1121 spreader units used in large cities, the percentage of tailgate spreaders (45%) was roughly equal to that of V-hopper spreaders (48%). Small and medium cities, on the other hand, preferred V-hopper spreaders by more than a two-to-one margin, 64% to 27%. The remaining spreaders were either towed (4% of the big city spreaders; 2% of the small), or small-vehicle spreaders (3% of the large cities'; 7% of the smaller jurisdictions').

All cities preferred heavy-duty plowing vehicles. In the large cities, these constituted 94% of the fleet, while small city fleets were 90% heavy duty. The remaining percentages were classified as "light duty."

In modernizing winter maintenance activities, large cities appear to lag behind smaller ones. For example, 65% of the 376 spreaders in use by small or medium cities were automated, while only 45% of the big cities' 1121 spreaders were automated.

Similarly, radio control of equipment was more prevalent in small to medium cities than in large ones. Seventy-four percent of the 509 plowing units and 92% of the 376 spreading units operated by smaller cities were radio controlled. For large cities, the figures were 64% of the 1577 plows and 80% of the 1121 spreaders.

Crew size

One-person crews were in widespread use by both large and small-to-medium cities. Ninety-five percent of the large cities used one-person crews for spreading, as did 96% of the smaller cities. For plowing, 84% of the large cities used one-person crews vs. 74% for the small cities.

The percentage of units manned by one-person crews was lower than the city-size figures would indicate, suggesting either that jurisdictions that reported one-person crews may not limit all units to this level of manning, or that the larger cities in each size category were more likely to use one-person crews. Of the 1497 spreaders operated by jurisdictions answering the survey, 82% were manned by a single operator, while 18% had a two-person crew. For the 2086 plows, the split was nearly equal: fifty-two percent were manned by a single operator, while 48% had a two-person crew.

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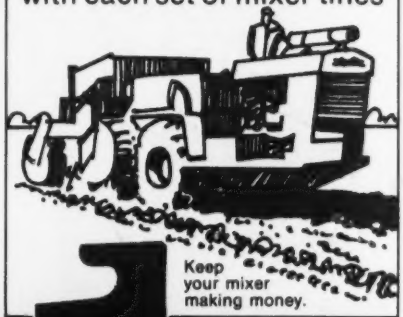

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The decision to use a one-person crew for spreading seemed to be highly dependent on the type of spreader being operated:

- Tailgate spreaders were operated by one-person crews in 61% of the large cities and 89% of the small cities
- V-hopper spreaders were operated by a single individual in 97% of the large cities and 91% of the small cities
- Towed spreaders were operated alone in only 48% of large cities and 63% of those in the "small" category
- Small vehicle spreaders were operated by a single individual in all instances in large cities, but smaller jurisdictions used a second crew member on 86% of the small-vehicle spreaders they operated.

The major motivating factors in the use of one-person crews were costs and productivity, two variations of the same theme. Nearly all cities, regardless of size, cited one or both of these factors.

Interestingly, a few cities — all with heavy snowfalls — cited safety as a reason for using one-person crews. This was contrary to the belief of those cities that rejected the use of one-person crews, where the major reason *for ruling out* the use of individual operators was safety. In fact, safety was the major motivating factor for multi-person crews in cities with light-to-medium snowfalls! Labor union demands were cited as a factor in rejecting single-person crews by only one of the cities Jester surveyed.

Half of the cities reported that radio control had enabled them to use one-person crews, while the other half indicated that this was not a reason for reducing crew size. Only in large cities with light-to-medium snowfall did radio control prove an important factor, and then a negative one. Two-thirds of these cities said that radio control was not a factor to be considered in cutting crew size.

Most cities using one-person crews reported having no safety problems with units operated in that manner. The major problem seemed to occur in cities with light-to-medium snowfalls, and even then it was considered a problem in fewer than one-fourth of the cities. Logically, these cities were more likely to substitute larger crews at times. Nearly half of the light-to-medium snowfall cities — 44% of the large ones and 46% of the smaller ones — reported substituting larger crews under certain conditions. Typically, the conditions that called for adding personnel were night operations and working on narrow, dead-end, or residential streets.

Cities with heavy snowfall were less likely to add crewmen. Only 14% of the smaller cities and 30% of the larger cities in this category substituted larger crews at times.

All cities were well experienced in the use of one-person crews. On both plows and spreaders, cities of all sizes had been using one-person crews for about ten years. Although in general cities had longer experience with two-person crews — up to 18 years — small to medium cities had more experience with one-person spreader crews (10 years) than they did with two-person crews (six years).

Materials

All of the cities surveyed used salt for snow and ice control. Most (76%) also used sand. Slightly more than half (52%) used calcium chloride, but the use of this material was more prevalent in cities with light-to-medium snowfall than in cities that received heavier snowfalls:

- 30% of the large cities with heavy snowfall used calcium chloride, and all of these used it in the liquid form
- 78% of the larger cities with light snowfall used calcium chloride, and 86% of these used it as a liquid
- 50% of the smaller cities with heavy snowfall used calcium chloride, and 57% of these used it as a liquid
- 54% of the small cities with light snowfall used calcium chloride, with 57% using it in the liquid form

Most cities (61%) used a combination of inside and outside storage for ice-control materials. About one-fourth stored everything inside, while a slightly smaller percentage — one-fifth — stored all materials outside. Small- to-medium cities were about twice as likely as their larger counterparts to use outside storage exclusively. One of the more interesting storage facilities mentioned was a railroad roundhouse.

Three-quarters of the surveyed cities had written procedures for snow and ice control, with larger cities somewhat more likely than smaller ones to be so prepared. Virtually all cities had established routes for plowing and spreading.

Both small cities and large seemed to take training equally seriously, with nearly all cities reporting some type of formal or on-the-job training procedures. Eighty-seven percent of the cities trained their employees on routes, while 93% trained on procedures.

While spreading nearly always seemed to be conducted by municipal forces — only nine percent of the cities reported using contractors for this work — plowing was another matter. Fifty seven percent of all cities used private contractors to aid in plowing, and 80% of the large cities with heavy snowfalls did so. **ACC**

What happened to the gold in garbage?

In the eleven years since President Nixon announced 'We must move increasingly toward closed systems that recycle what now are considered wastes back into useful and productive purposes. . . ,' at least seven large corporations that had been involved in resource recovery have disappeared. A new study details the financial risks of recovering anything of value from refuse.

By Oscar Albrecht
Senior Economist
Industrial Environmental Research Laboratory, USEPA

"What went wrong?" is the plaintive cry raised whenever pots of gold disappear along with the rainbows. The rainbows, in this case, arched between the rising costs of land disposal and the sudden realization that municipal refuse contained valuable materials.

More than a decade has elapsed since the U.S. Congress passed the Resource Conservation and Recovery Act of 1970, but fewer than three dozen facilities for recovering fuel, materials, or energy from solid wastes currently are fully operational. Only about two percent of the nation's solid waste disposal requirements are being met in resource recovery facilities, and at least seven large corporations that had been involved in designing, constructing, or operating recovery facilities no longer exist.

What went wrong?

Certainly solid waste disposal has not become less of a problem. Not only has the public become increasingly vocal in its opposition to using land for disposal purposes, but there is more competition for whatever land is available. The volume of wastes that must be handled continues to increase, too. The total amount of commercial and residential solid waste generated in 1980 was estimated to be about 150 million metric tons. By 1990, this quantity is expected to be about 200 million metric tons.

With the quantity of solid wastes increasing costs and difficulties of landfilling similarly increasing, and the fact that refuse contains resources of measureable value acknowledged, why are there so few successful facilities now processing it to recover some of this value and decrease the amount that must be buried? The answer to this question can best be found by a careful financial study of a representative sample of the facilities that are operating.

The U.S. Environmental Protection Agency awarded a contract to Mathtech Inc., of Princeton, New Jersey, to perform just such a study. Mathtech used three primary criteria to select plants for study:

- The plants had to be using currently

Representative resource recovery plants

Location	Process	Design Throughput (tons/day)	Actual throughput (tons/day)	Capital investment ($million)	Net disposal cost ($ per ton)	Estimated profit, (loss) ($ per ton)	Landfilling cost ($ per ton)
Ames, Iowa	RDF and materials recovery	400	200	10.9	20.50	(10.60)	800–12.00
Braintree, Massachusetts	Waterwall incinerator	240	186	7.5	28.33	(10.89)	17.00–20.00
Harrisburg, Pennsylvania	Waterwall incinerator and materials recovery	720	430	28.1	20.42	(2.60)	4.50–7.50
Milwaukee, Wisconsin	RDF and materials recovery	1600	640	34.6	25.27	(9.18)	8.00–12.00
Monmouth City, New Jersey	Shredding and materials recovery	400	375	5.3	12.56	(7.96)	2.50–7.50
Mountain View, California	Landfill gass recovery	1.0*	0.5*	1.0	6.45	0.76	6.84
New Castle Cnty, Delaware	Shredding and materials recovery	800	300	10.2	10.92	(1.94)	N.A.
N. Little Rock, Arkansas	Modular incinerarator	100	82	1.9	14.02	(8.17)	3.33

*Million standard cubic feet of gas per day

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accepted technology.

- They had to be currently operating, and to have been in continuous operation for at least a year — preferably for two years.
- Plant operators had to have adequate operational and financial records and be willing to make this data available to the researchers.

Mathtech selected eight plants that met these criteria. The technologies used by these plants included modular and waterwall incinerators, shredders with materials recovery, refuse-derived fuel (RDF) production, and methane recovery from landfill gas. Plant capacities ranged from 100 to 1600 tons per day. Half the plants were in the Northeast.

Each plant's operations were analyzed with regard to its net disposal cost; that is, the total cost less any income from sales of recovered materials or energy. This analysis showed that in 1978, the last full year for which data were accumulated, none of the facilities gained sufficient income to cover expenses. Losses ranged from $0.60 to more than $36.00 per ton. Moreover, the facilities were uneconomical in that they did not provide the least costly disposal method available locally.

It is improbable that planners for these facilities anticipated this dreary state of financial affairs. Officials who made the decisions to construct the plants must have been sufficiently encouraged by initial projections that they were willing to undertake the investments.

Projections too optimistic

Unfortunately, the projections seem to have been universally optimistic. Those made for the Ames, Iowa, RDF plant were typical:

- The anticipated capital cost of the facility was $5.56 million; actual capital cost was $6.30 million.
- The anticipated annual operating and maintenance costs were $4.55 per ton of refuse. In 1977, actual O&M costs were $11.22 per ton.
- The plant was scheduled to process 54,740 tons of refuse in 1975. In 1977, it actually processed 48,400 tons, and little more is available in the area.
- The anticipated 1975 value of the RDF was $.07 per ton. The actual 1977 value was $7.29 per ton.
- The anticipated value of the recovered materials was $3.13 and $5.74 per ton. Actual value in 1977 was $2.17 per ton.

Other facilities experienced similarly inaccurate forecasts. Expenditures for the structures and equipment ranged to as much as 40 to 60 percent higher than anticipated. This increased net disposal costs by as much as $5.00 per ton.

Perhaps the biggest barrier to profitable resource recovery operations is the relatively low cost of competitive disposal in a landfill. Where wastes could be taken to a landfill, this "competition" reduced the volume taken to a recovery facility, and held down the tipping fee that the plant could charge.

Landfill disposal costs currently average only a little more than $4.00 per ton nationally. Regionally, variations are fairly wide, depending in part upon the environmental soundness of the landfilling operation. Still, even if landfill costs were to double, as another EPA study suggests is possible as landfilling is upgraded to comply with full Resource Conservation and Recovery Act provisions, many resource recovery facilities still could not compete on a strictly economic basis.

In Monmouth County, New Jersey, and North Little Rock, Arkansas, for example, landfill costs would need to triple before the plants could break even with comparable tipping fees. Even under the most stringent environmental regulatory enforcement, this appears improbable.

Harrisburg, on the other hand, would break even if its tipping fee could be increased only 30 to 40 percent, and Ames would eliminate its operating deficit with a 42 percent increase in its tipping fee. In Braintree, a 79 percent increase in tipping fee would be needed for break-even operation, and Milwaukee's fee would need to be doubled.

The Mathtech study did not attempt to quantify the financial penalties attributable to operational difficulties. The problems of shredder explosions, aluminum separation, screen blanking, boiler corrosion and slagging, and low-quality separated materials are well documented.

Environmental regulations, surprisingly enough, also contribute to the lack of financial success in resource recovery. Air quality regulations have severely restricted the burning of coal, and most industrial and utility boilers constructed in the 1970s were designed to burn oil or natural gas, or were nuclear fueled. Because of this, the possibilities for co-firing RDF with coal are rare. In addition, environmental constraints on the recycling or disposal of bottom ash from plants firing RDF made the use of that fuel more costly or even economically impossible.

Another factor contributing to the unprofitability of some facilities was their unrealistic pricing. This was particularly important in the case of energy sales. Contracts often obligated the facility to sell steam or refuse-derived fuel at a fixed price over a long time period, without regard for the cost escalation of competitive fuels.

Some factors commonly considered to be obstacles to resource recovery proved to be less important than popularly thought. Only one of the facilities had to overcome any public opposition to its siting. Source separation programs and legislation mandating returnable beverage containers also did not have any appreciable effect on resource recovery operations. Other governmental policies and regulations seemed equally insignificant in affecting the facilities.

Is success achievable?

Determining the financial success of a facility designed for the disposal of municipal refuse is not merely a matter of determining whether income exceeds expenditures. Local government must ensure that solid wastes are properly discarded. Financial success means accomplishing this at the lowest possible cost, not necessarily making a "profit."

A high tipping fee would provide a low net disposal cost, but the competition from low-cost landfills makes high tipping fees generally infeasible. Still, one facility that enjoyed a monopoly in disposal nevertheless did not set its tipping fee high enough to cover its operating costs.

Increasing the throughput at a plant is another way of raising its profitability. Unfortunately, Mathtech's analy-

Hypothetical break-even tipping fees, 1977 dollars/ton

Facility type	Small design	Large design
Modular incinerator, steam sales	$8.83	$3.91
Mass-burning waterwall incinerator; steam sales	$5.79	$3.06
Semi-suspension waterwall incinerator; steam sales, ferrous recovery	$4.68	($0.25)
Refuse-derived fuel production; ferrous, aluminum, and glass recovery	$16.43	$10.70
Shredding with ferrous, aluminum, and glass recovery	$11.25	$8.30

Note: Small design assumes 50 tons per day for modular incinerators, 500 tons per day for all other type facilities. Large design assumes 100 tons per day for modular incinerators, 1500 tons per day for all other type facilities.

sis revealed that fully half of the plants could not increase their throughput to the extent that they could break even financially. In some cases, this was because operating costs per ton were so high that even capacity-level operations would not yield sufficient revenues to cover costs. In at least one case, the facility already was receiving nearly all of the available refuse.

Can profits increase?

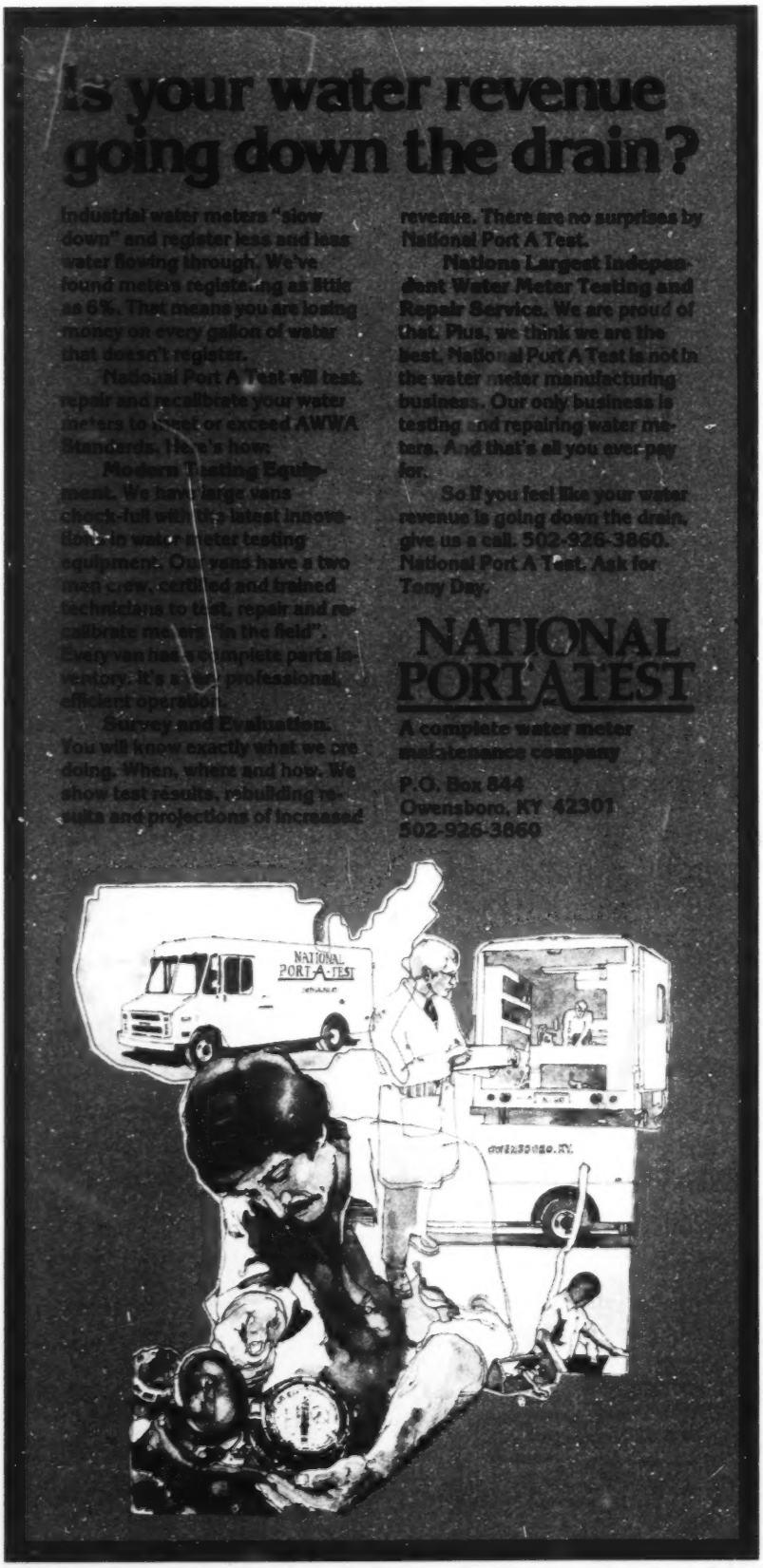
Theoretically, increasing the rates of energy and materials recovery would be a way of improving profitability. In actuality, this is not realistic. Recovering all of the ferrous scrap in mixed refuse — and presuming that it could be sold — still would make only a modest contribution to facility revenues. And aluminum recovery is not taking place at a significant level at any of the facilities studied.

Although Milwaukee's operation could become a break-even situation if it could market 60 percent of the energy potential in the refuse it processes, that plant currently has no customers for its refuse-derived fuel. Ames currently recovers 75 percent of the potential energy from its wastes, and any increase in this rate probably would be accompanied by a decrease in the quality of the RDF to the extent that it would have lower value. Other steam-producing plants already recover more energy than their customers can use.

Harrisburg could break even if it could raise the price of the energy it sells by 44 percent. This is not an unreasonable possibility within the foreseeable future, but a similar situation does not exist for the other plants. The price of energy would need to essentially double before North Little Rock or Ames would become break-even operations. At Braintree and Milwaukee, the price increases would need to be 200 and 400 percent, respectively. Prices for secondary materials would need to increase two to five times current levels to produce break-even situations.

In all, the Mathtech study suggests that the possibility of a community constructing a profitable resource recovery facility is remote, indeed. In general, existing plants not only are not profitable, they are not even the least costly method of disposal. Moreover, no single change would allow them to become profitable.

There is no doubt that resource conservation provides a direct benefit to society. Unfortunately, no agreement has yet been reached about the monetary value that should be assigned to this benefit. Until this is done, any large investment in resource recovery will continue to be considered financially questionable. **ACC**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Municipal Cost Indexes

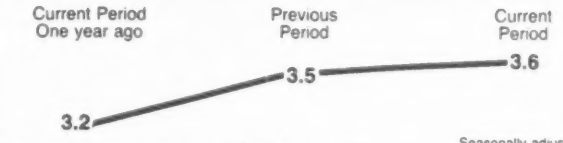
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 290.3 +0.7% +10.9%

Consumer Price Index	269.0	0.8%	9.8%
ACC Construction Cost Index	315.1	0.6	10.2
General Construction Materials	301.9	0.4	11.4
Motorized Equipment	270.8	1.4	14.1
Energy; Fuels and Power	864.8	1.1	30.9
Consumable Supplies	284.2	0.2	13.5
Producer Price Index	268.9	0.4	10.5

MUNICIPAL TREND TO WATCH

Government Purchases of Trucks, Billions of Dollars



Current Reference Period: First Quarter, 1981

Seasonally adjusted annual rate

CAPITAL EQUIPMENT 262.6 +0.8% +10.9%

Agricultural Machinery & Equip.	284.4	1.1%	10.9%
Air Conditioners (12/77 = 100)	127.4	0.6	5.6
Construction Machinery & Equip.	318.3	1.1	11.3
Electric Motors	269.9	0.1	8.6
Environmental Controls (6/80-100)	102.4	0.5	—
Fans and Blowers (Ex. Portable)	314.2	0	7.2
Fluid Power Equipment	219.6	1.5	10.9
Generators and Generator Sets	324.3	0[2]	17.3
Heating Equipment	221.7	1.3[2]	8.7
Industrial Material Handling Equip.	276.8	2.2[2]	9.6
Integrating & Measuring Inst.	195.3	0.7	7.1
Internal Combustion Engines	295.3	0%	11.8%
Motor Trucks, Light	248.7	0.9	15.8
Motor Trucks, Heavy	275.8	2.1	11.8
Office Machines	147.1	0.1[2]	4.7
Passenger Cars	204.5	1.2	9.9
Photographic Equipment	130.2	0.2	5.4
Pumps, Compressors & Equipment	319.8	1.2	12.1
Railroad Equipment	337.1	(1.4)[2]	8.6
Refrig. Compressors (12/77 = 100)	128.1	0.2[2]	4.7
Switchgear, Switchboard Equip.	245.3	(0.2)	4.3

INDUSTRIAL COMMODITIES 310.5 +0.5% +11.1%

Abrasive Products	274.6	0.7%[2]	9.4%
Apparel	182.4	0.2	7.2
Asphalt Roofing	412.4	(0.9)	2.8
Building Paper and Board	236.9	2.2	14.6
Coal	487.7	0.3	4.5
Commercial Furniture	256.9	1.0[2]	9.8
Concrete Products	290.7	0.4	5.6
Diesel Fuel (2/72 = 100)	864.9	(0.6)[2]	24.2
Drugs and Pharmaceuticals	223.2	0[2]	11.3
Electric Lamps/Bulbs	268.5	(0.1)[2]	9.8
Electric Power	360.7	1.4	14.0
Electronic Components	166.3	0.1	7.1
Fabricated Structural Metal	294.3	0.3	9.0
Finished Lubricants	341.8	0.4[2]	11.2
Finished Steel Products	330.9	0.1	8.8
Flat Glass	208.1	0[2]	6.6
Floor Coverings	179.9	2.1	11.1
Footwear	241.1	0	4.0
Footwear, Rubber	219.2	0	5.8
Foundry Products	326.6	1.0	6.5
Fuel Oil, No. 2 (2/73 = 100)	689.0	(1.6)	27.6
Gasoline	747.6	(0.6)	16.1
Glass Containers	334.5	2.6	13.7
Gypsum Products	261.1	1.7	1.8
Hand Tools, Power (12/76=100)	138.8	(0.1)[2]	10.1
Hardware	257.3	0.4[2]	7.9
Industrial Chemicals	366.6	1.6[2]	11.6
Kerosene (2/73 = 100)	863.0	(0.5)	28.3
Lumber, Softwood	253.9	1.0	0.6
Lumber, Hardwood	356.4	1.1%	14.0%
Millwork	274.8	(0.6)	9.1
Mixed Fertilizers	265.4	0.8	8.8
Motor Vehicle Parts	313.8	0.1	28.2
Natural Gas	1034.5	3.5[2]	26.8
Nonferrous Wire and Cable	209.2	0	(3.4)
Paint Materials	300.1	1.7	9.6
Paper	276.1	0.2	7.8
Paperboard	262.3	1.7	11.4
Pesticides	381.9	0[2]	1.5
Photographic Supplies	274.9	0.9	7.3
Plastic Constr. Prod. (12/69 = 100)	155.1	0.1	1.2
Plastic Film (12/70 = 100)	207.4	0	11.3
Plumbing Fixtures & Brass Fittings	265.6	0.2	7.3
Plywood	248.4	(2.4)	7.7
Portland Cement	329.1	0.1	4.8
Prepared Paint	250.4	0.8[2]	4.9
Refractories	304.2	2.3	15.1
Residual Fuel	1316.3	0.1	51.3
Sand, Gravel & Crushed Stone	263.5	0.4	13.1
Sanitary Papers & Health Prod.	349.2	0.4	8.4
Soaps & Synthetic Detergents	238.7	0.1[2]	11.6
Sporting Goods	212.3	0.3	8.3
Structural Clay Products	249.6	1.6[2]	8.5
Tires and Tubes	250.8	0.2	7.5
Tractor Parts	209.3	0[2]	15.6
Transformers & Power Regulators	206.5	1.0[2]	15.6
Valves & Fittings	308.3	0.2	6.6
Wiring Devices	294.8	0	12.2

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted

SEPTEMBER 1981

American City & County

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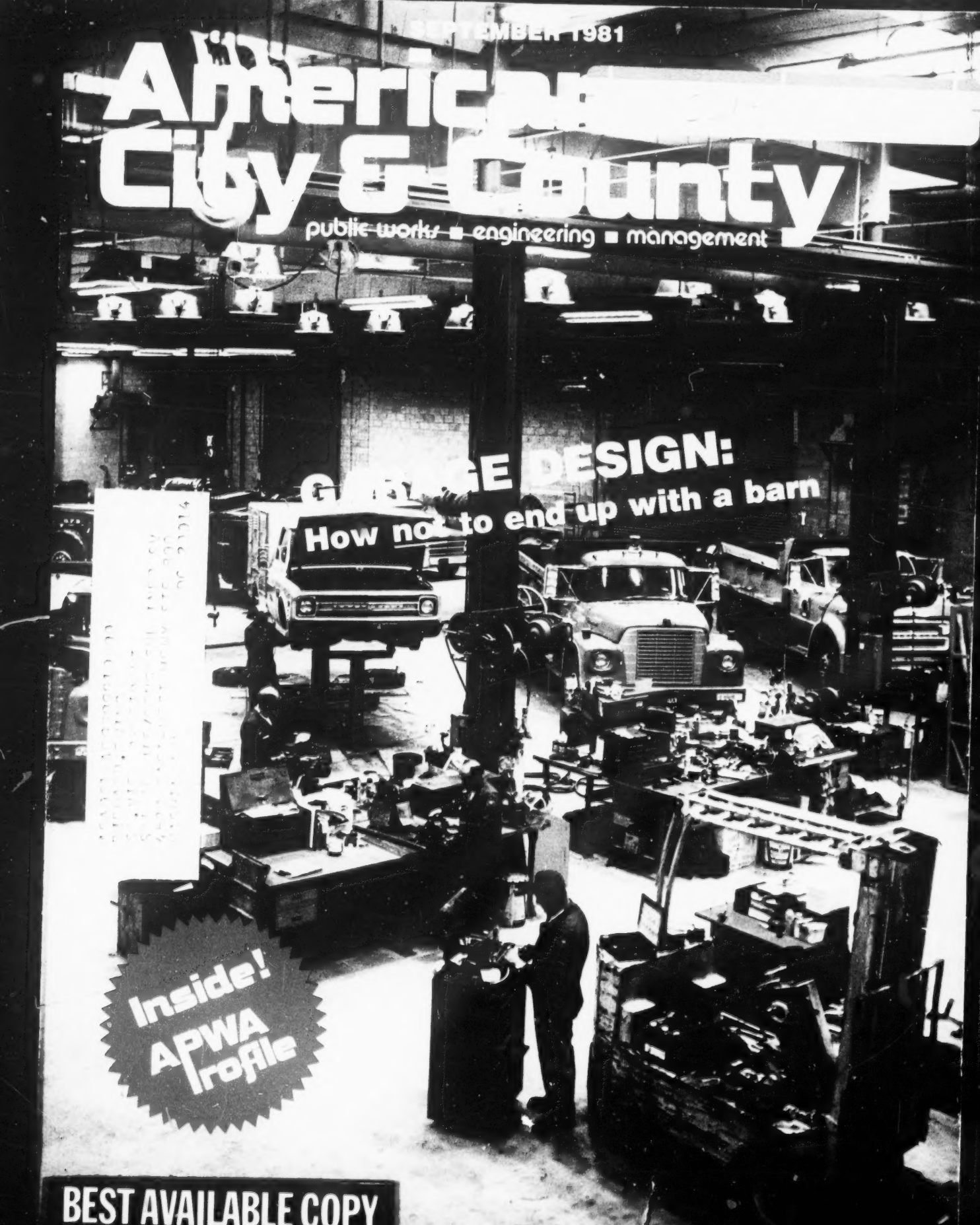

GARAGE DESIGN:
How not to end up with a barn

Inside!
APWA Profile

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Municipal Cost Indexes

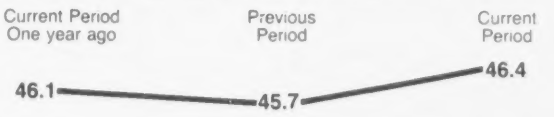
Cost Index Figures of the Month, showing 30-day[1], 12-month changes (1967=100)

ACC MUNICIPAL COST INDEX 292.3 +0.7% +10.3%

Consumer Price Index	271.3	0.9%	9.6%
ACC Construction Cost Index	317.4	0.7	9.2
General Construction Materials	303.5	0.5	10.5
Motorized Equipment	273.6	1.0	14.8
Energy; Fuels and Power	861.6	(0.4)	30.6
Consumable Supplies	285.2	0.4	13.0
Producer Price Index	269.9	0.4	10.2

MUNICIPAL TREND TO WATCH

Purchases of Structures, Billions of Dollars



Current Reference Period: First Quarter 1981

Seasonally adjusted annual rate

CAPITAL EQUIPMENT 264.0 +0.5% +11.0%

Agricultural Machinery & Equip.	285.9	0.5%	11.2%
Air Conditioners (12/77 = 100)	128.4	0.8	4.6
Construction Machinery & Equip.	320.0	0.5	11.3
Electric Motors	271.2	0.5	9.1
Environmental Controls (6/80-100)	103.4	1.0	3.4
Fans and Blowers (Ex. Portable)	319.0	1.5	8.1
Fluid Power Equipment	220.6	0.5[2]	10.4
Generators and Generator Sets	328.0	1.1[2]	15.6
Heating Equipment	222.9	0.5[2]	8.7
Industrial Material Handling Equip.	276.9	0[2]	9.1
Integrating & Measuring Inst.	197.6	1.2	7.6
Internal Combustion Engines	296.8	0.5%	12.3%
Motor Trucks, Light	248.6	0	17.5
Motor Trucks, Heavy	283.0	2.6	14.7
Office Machines	147.0	(0.1)[2]	4.1
Passenger Cars	205.3	0.4	9.8
Photographic Equipment	130.3	0.1	2.7
Pumps, Compressors & Equipment	322.6	0.9	12.8
Railroad Equipment	337.4	0.1[2]	8.1
Refrig. Compressors (12/77 = 100)	128.1	0[2]	4.7
Switchgear, Switchboard Equip.	246.9	0.7	5.1

INDUSTRIAL COMMODITIES 311.0 +0.2% +10.5%

Abrasive Products	276.2	0.6%[2]	8.9%
Apparel	185.0	1.4	7.1
Asphalt Roofing	422.5	2.4	5.4
Building Paper and Board	236.8	0	13.4
Coal	491.8	0.8	5.4
Commercial Furniture	258.1	0.5[2]	9.6
Concrete Products	293.2	0.9	6.3
Diesel Fuel (2/72 = 100)	861.1	(0.4)[2]	24.9
Drugs and Pharmaceuticals	223.2	0[2]	11.0
Electric Lamps/Bulbs	268.5	0[2]	6.7
Electric Power	366.9	1.7	12.5
Electronic Components	166.4	0.1	6.0
Fabricated Structural Metal	295.4	0.4	9.4
Finished Lubricants	342.8	0.3[2]	10.1
Finished Steel Products	331.0	0	8.7
Flat Glass	208.1	0[2]	7.5
Floor Coverings	181.1	0.7	11.7
Footwear	241.0	0	3.9
Footwear, Rubber	219.4	0.1	5.9
Foundry Products	329.6	0.9	6.2
Fuel Oil, No. 2 (2/73 = 100)	891.9	0.3	28.1
Gasoline	743.3	(0.6)	15.2
Glass Containers	334.5	0	13.7
Gypsum Products	260.7	(0.2)	1.4
Hand Tools, Power (12/76=100)	138.8	0[2]	10.9
Hardware	257.6	0.1[2]	7.1
Industrial Chemicals	369.4	0.8[2]	12.1
Kerosene (2/73 = 100)	857.4	(0.6)	27.5
Lumber, Softwood	255.3	0.6	2.0
Lumber, Hardwood	356.1	(0.1)%	8.4%
Millwork	272.9	(0.7)	7.9
Mixed Fertilizers	265.1	(0.1)	8.9
Motor Vehicle Parts	314.1	0.1	27.1
Natural Gas	1080.4	4.4[2]	31.1
Nonferrous Wire and Cable	206.9	(1.1)	(2.5)
Paint Materials	300.8	0.2	9.4
Paper	278.8	1.0	8.1
Paperboard	262.7	0.2	10.0
Pesticides	444.8	16.5[2]	18.3
Photographic Supplies	274.9	0	7.0
Plastic Constr. Prod. (12/69 = 100)	155.4	0.2	0.5
Plastic Film (12/70 = 100)	207.8	0.2	8.4
Plumbing Fixtures & Brass Fittings	268.2	1.0	7.9
Plywood	250.9	1.0	3.8
Portland Cement	328.9	(0.1)	4.8
Prepared Paint	250.4	0[2]	4.9
Refractories	307.3	1.0	15.6
Residual Fuel	1255.8	(4.6)	47.1
Sand, Gravel & Crushed Stone	263.6	0	12.6
Sanitary Papers & Health Prod.	349.2	0	7.8
Soaps & Synthetic Detergents	239.3	0.3[2]	11.6
Sporting Goods	212.1	(0.1)	7.4
Structural Clay Products	249.5	0[2]	8.4
Tires and Tubes	250.8	0	6.5
Tractor Parts	210.2	0.4[2]	16.0
Transformers & Power Regulators	208.2	0.8[2]	15.8
Valves & Fittings	308.9	0.2	6.0
Wiring Devices	300.6	2.0	13.2

1) Thirty-day figures seasonally adjusted, except where noted 2) Not seasonally adjusted